

## **Appendix G**

### **Identification of Columbia River Basalt Group Flows**

## Appendix G

### Identification of Columbia River Basalt Group Flows

This appendix is designed as a tool to identify the stratigraphic interval encountered during drilling.

#### 1.0 Identification of Columbia River Basalt

Lava flows of the Columbia River Basalt Group (Figure G.1) are identified using a combination of lithology, paleomagnetic properties, and chemical composition. Experience is the best way of making correct identifications but the chemical composition provides the least ambiguous way of properly identifying a lava flow. Table G.1 shows the chemical composition of the larger lava flows of the Columbia River basalt Group. Although this selection does not include every flow known, it provides compositions of the ones that will be of most importance for characterization because of their great lateral extent.

The compositions in Table G.1 are listed from the youngest at the top to the oldest at the bottom. The names are those shown in Figure G.1. Variation diagrams shown in Figures G.2 through G.9 are useful plots for distinguishing many of the lava flows. Geologic maps and distribution maps of the lava flows provide a first “cut” at determining what lava flows should or should not be present at a site. Figure G.10 is a geologic map showing the distribution of the main formations. Figure G.11 is a geologic map showing the distributions of the main lava flows. Figure G.12 shows the distribution of the main lava flows in Figure G.1.

##### 1.1. Procedure.

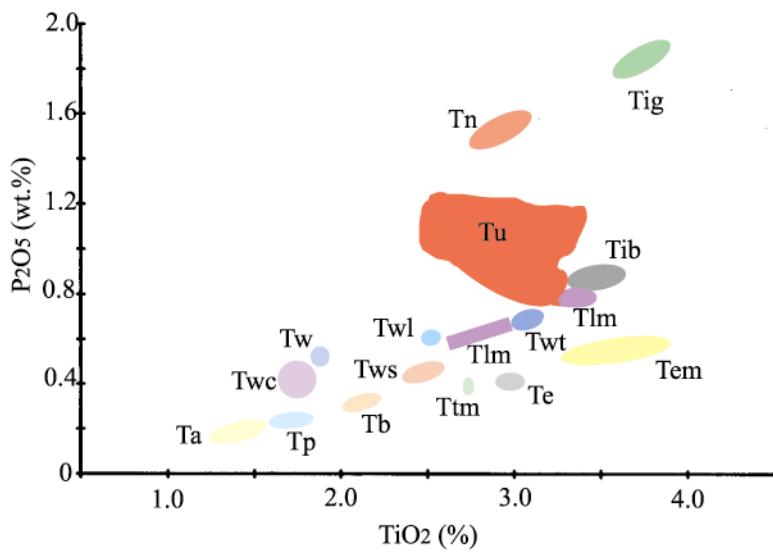
- Upon determining the location of the characterization borehole, first determine the uppermost lava flow exposed at the surface. This should be done by first consulting the geologic map for the area. Figures G.10, G.11, and G.12 provide maps showing which lava flows can be expected to be present at a site. However, these are small scale and it is recommended that the 1:100,000 scale geologic maps be used (Appendix H). The Columbia Basin has been mapped in very good detail so the surface flow identification should be reliable.
- Once the surface flow has been identified, consult the maps showing the distribution for the various lava flows of the Columbia River Basalt Group in Figure G.12. The distribution maps will allow you to determine the stratigraphic units that are present in your area.
- Upon determining the stratigraphic units present in your area, you can assemble a representative chemical composition stratigraphy for your area from Table G.1.
- Once you have received the chemistry from samples that you have submitted for analysis, match the analyses to your “theoretical” stratigraphy. The most important oxides to consider are:

- TiO<sub>2</sub>
  - MgO
  - P<sub>2</sub>O<sub>5</sub>
  - Zr
- Most Saddle Mountains Basalt will be easy to discriminate because of the diverse chemistry of the flows (e.g., Figure G.2).
- TiO<sub>2</sub> and P<sub>2</sub>O<sub>5</sub> will allow an initial discrimination (e.g., Figure G.3). Flows of the Wanapum Basalt typically will have higher TiO<sub>2</sub> than the Grande Ronde Basalt. Often when TiO<sub>2</sub> is used in conjunction with other trace elements such as Ba (Figure G.4) or Cr (Figure G.5), a finer discrimination can be recognized. P<sub>2</sub>O<sub>5</sub> with trace elements is also useful (Figure G.6).
- Grande Ronde Basalt flows will be the most difficult to separate. TiO<sub>2</sub> and Cr (Figure G.5) allow some discrimination. The upper most flows will be the high MgO Member of Sentinel Bluffs flows (Figure G.1). The Sentinel Bluffs flows are wide spread and will be easily recognized. A distinctive flow called the Member of Umtanum flow (Figure G.1) and a compositionally similar one called the Member of Winter Water flow(s) underlie the Sentinel Bluffs flows. Deeper Grande Ronde Basalt flows will be more difficult to distinguish and direct compositional comparisons should be made to Table G.1. Figures G.7, G.8, and G.9 provide other examples of useful discriminations.

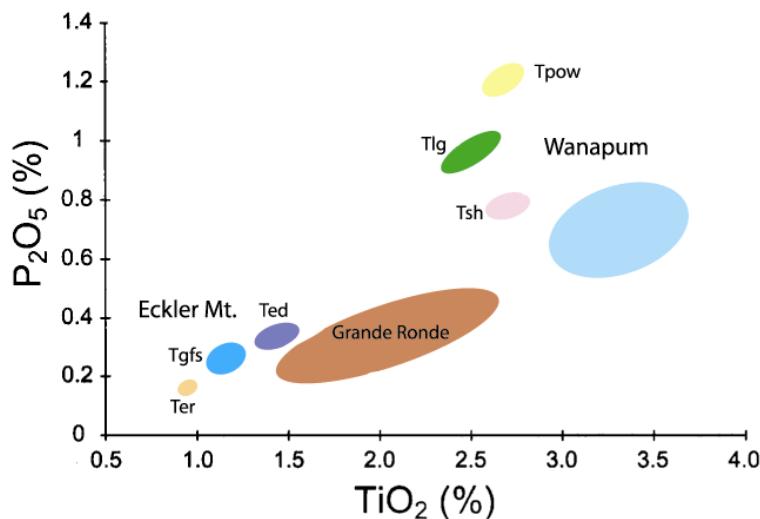
Series	Group	Formation	Member	Isotopic Age (m.y.)	Magnetic Polarity
	Upper		Lower Monumental Member	6	N
			Ice-Harbor Member	8.5	N
			Basalt of Goose Island		R
			Basalt of Martindale		N
			Basalt of Basin City		R
			Buford Member		N
			Elephant Mountain Member	10.5	T
			Pomona Member	12	R
			Esquatzel Member		N
		Saddle Mountains Basalt	Weissenfels Ridge Member		
			Basalt of Slippery Creek		N
			Basalt of Tenmile Creek		N
			Basalt of Lewiston Orchards		N
			Basalt of Cloverland		N
			Asotin Member	13	
			Basalt of Huntzinger		N
			Wilbur Creek Member		
			Basalt of Lapwai		N
			Basalt of Wallowa		N
			Umatilla Member		
			Basalt of Siliusi		N
			Basalt of Umatilla		N
Miocene	Middle	Columbia River Basalt Group	Priest Rapids Member	14.5	R
			Basalt of Lolo		R
			Basalt of Rosalia		T, R
			Roza Member		
			Shumaker Creek Member		N
		Yakima Basalt Subgroup	Frenchman Springs Member		
			Basalt of Lyons Ferry		N
			Basalt of Sentinel Gap		N
			Basalt of Sand Hollow	15.3	N
			Basalt of Silver Falls		N, E
			Basalt of Ginkgo	15.6	E
			Basalt of Palouse Falls		E
		Wanapum Basalt	Eckler Mountain Member		
			Basalt of Dodge		N
			Basalt of Robinette Mountain		N
			Vantage Horizon		
		Grande Ronde Basalt	Member of Sentinel Bluffs	15.6	
			Member of Slack Canyon		N <sub>2</sub>
			Member of Fields Spring		
			Member of Winter Water		
			Member of Umatum		
			Member of Ortley		
			Member of Armstrong Canyon		
			Member of Meyer Ridge		
			Member of Grouse Creek		
			Member of Wapshilla Ridge		R <sub>2</sub>
			Member of Mt. Horrible		
			Member of China Creek		N <sub>1</sub>
			Member of Downy Gulch		
			Member of Center Creek		
			Member of Rogersburg		R <sub>1</sub>
			Teepee Butte Member		
			Member of Buckhorn Springs	16.5	R <sub>1</sub>
		Imnaha Basalt			T
					N <sub>0</sub>
					R <sub>0</sub>
				17.5	

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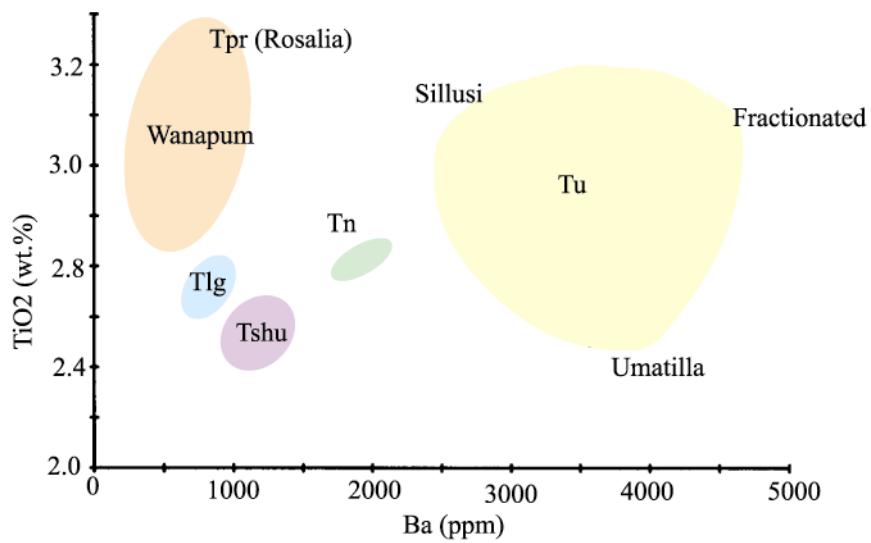
**Figure G.1.** Stratigraphic Nomenclature for the Columbia River Basalt Group that is Used in this Report



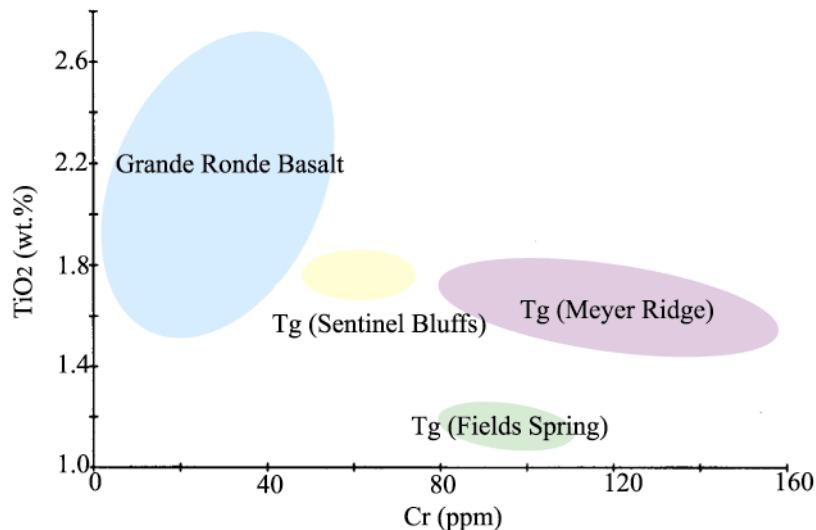
**Figure G.2.**  $\text{TiO}_2$  Versus  $\text{P}_2\text{O}_5$  for all Saddle Mountains Basalt Flows



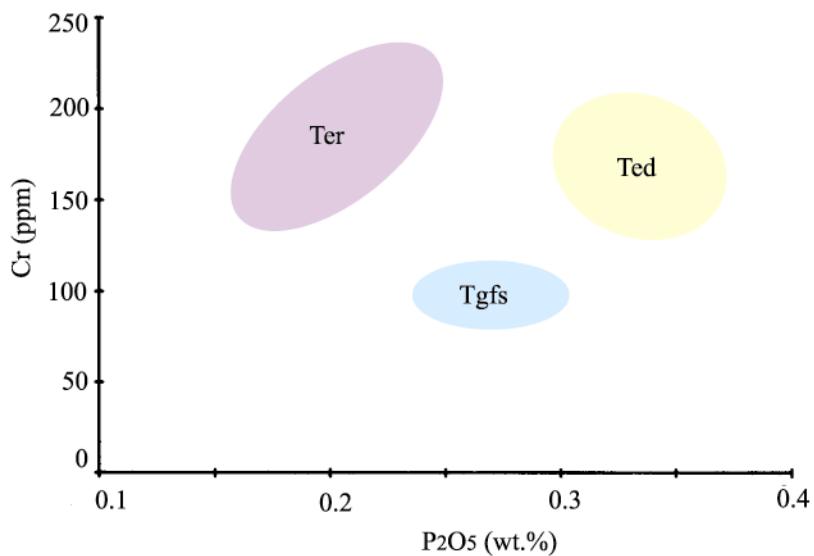
**Figure G.3.**  $\text{TiO}_2$  Versus  $\text{P}_2\text{O}_5$  for Grande Ronde Basalt, Wanapum Basalt and Eckler Mountain Member



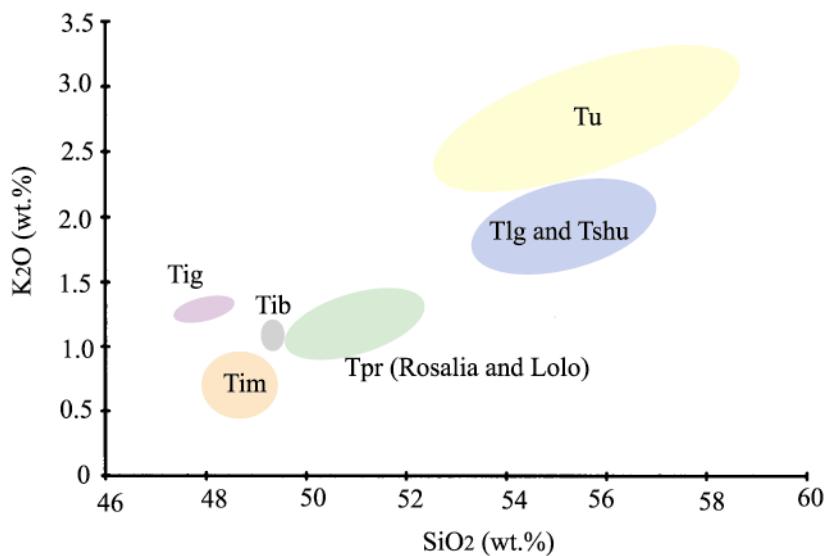
**Figure G.4.**  $\text{TiO}_2$  Versus Ba for the Wanapum Basalt and Selected Flows of the Saddle Mountains Basalt and Eckler Mountain Member



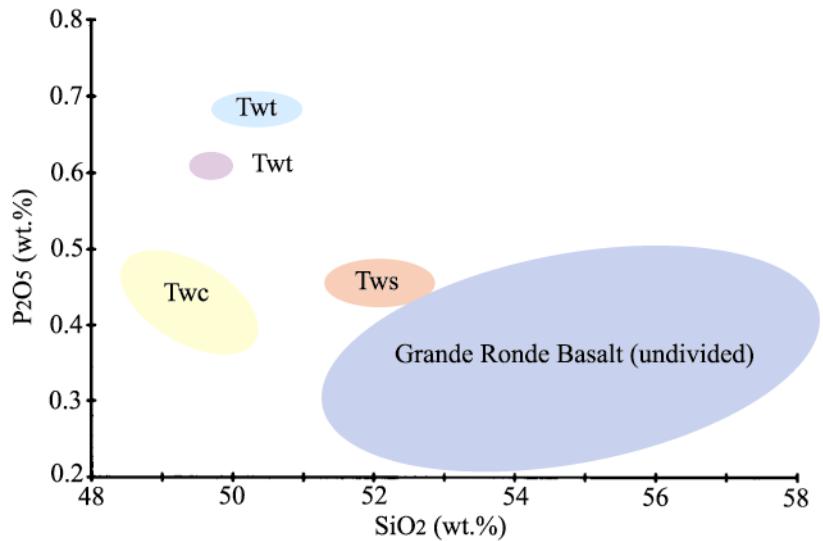
**Figure G.5.**  $\text{TiO}_2$  Versus Cr for Selected Flows of the Grande Ronde Basalt



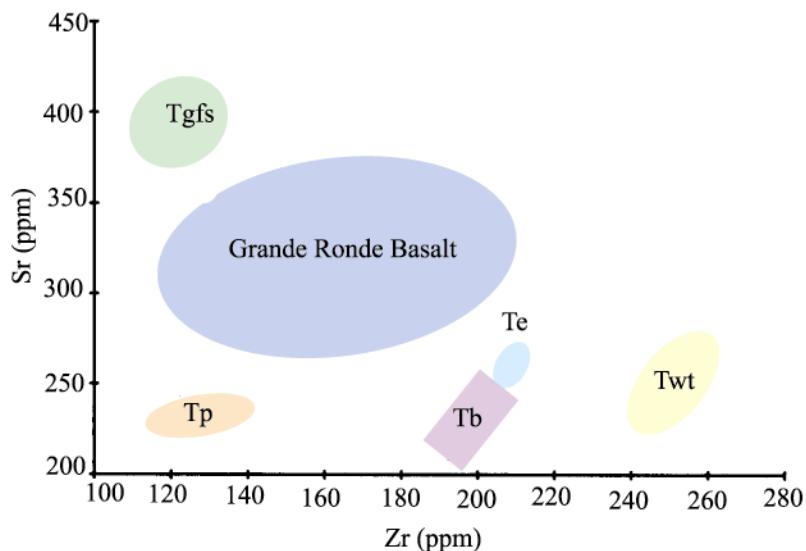
**Figure G.6.** P<sub>2</sub>O<sub>5</sub> Versus Cr for the Fields Spring Member of the Grande Ronde Basalt and the Selected Flows of the Eckler Mountain Member



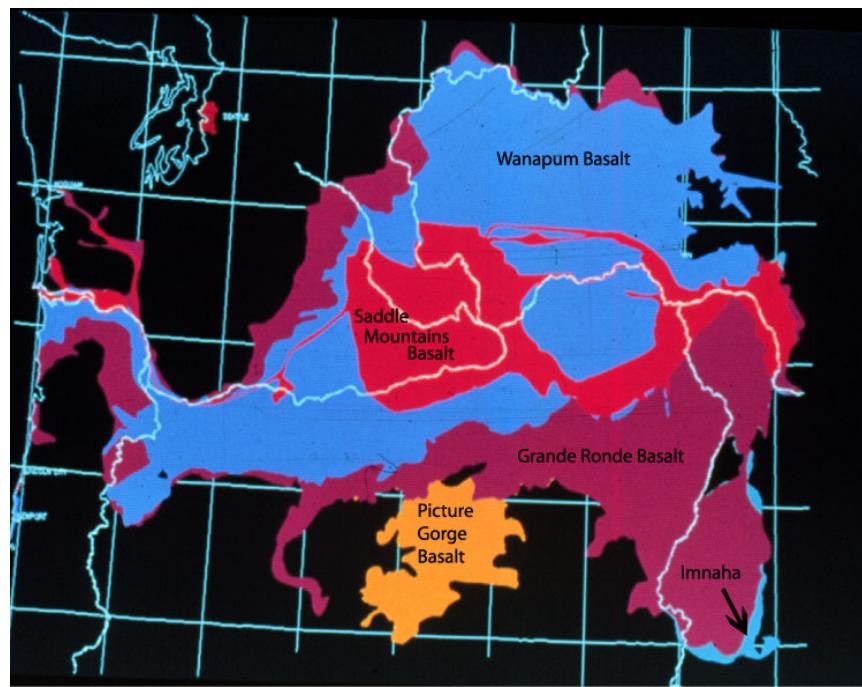
**Figure G.7.** K<sub>2</sub>O Versus SiO<sub>2</sub> for Ice Harbor Member, Umatilla Member and Priest Rapids Member Flows



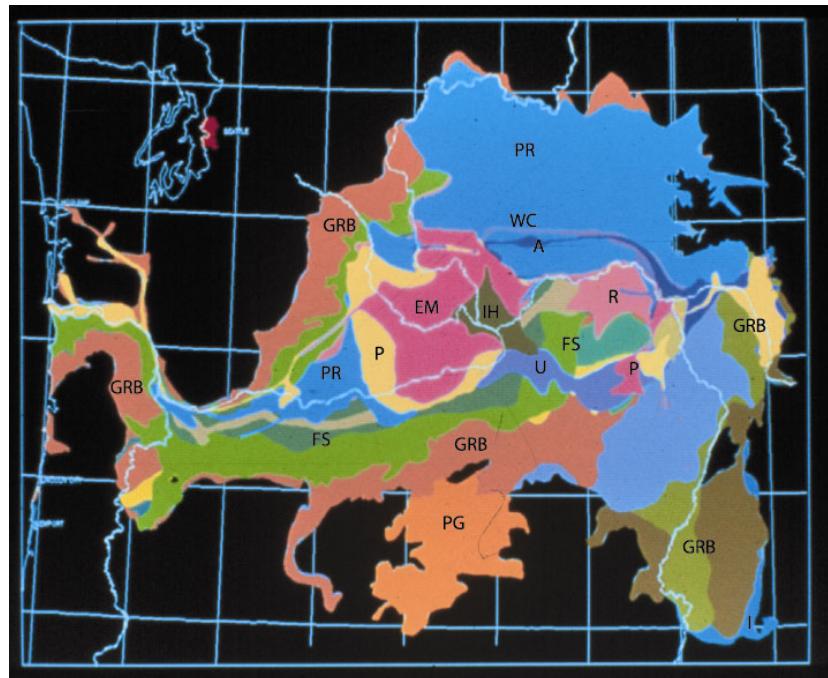
**Figure G.8.** SiO<sub>2</sub> Versus P<sub>2</sub>O<sub>5</sub> for Grande Ronde Basalt and Selected Saddle Mountains Basalt Flows



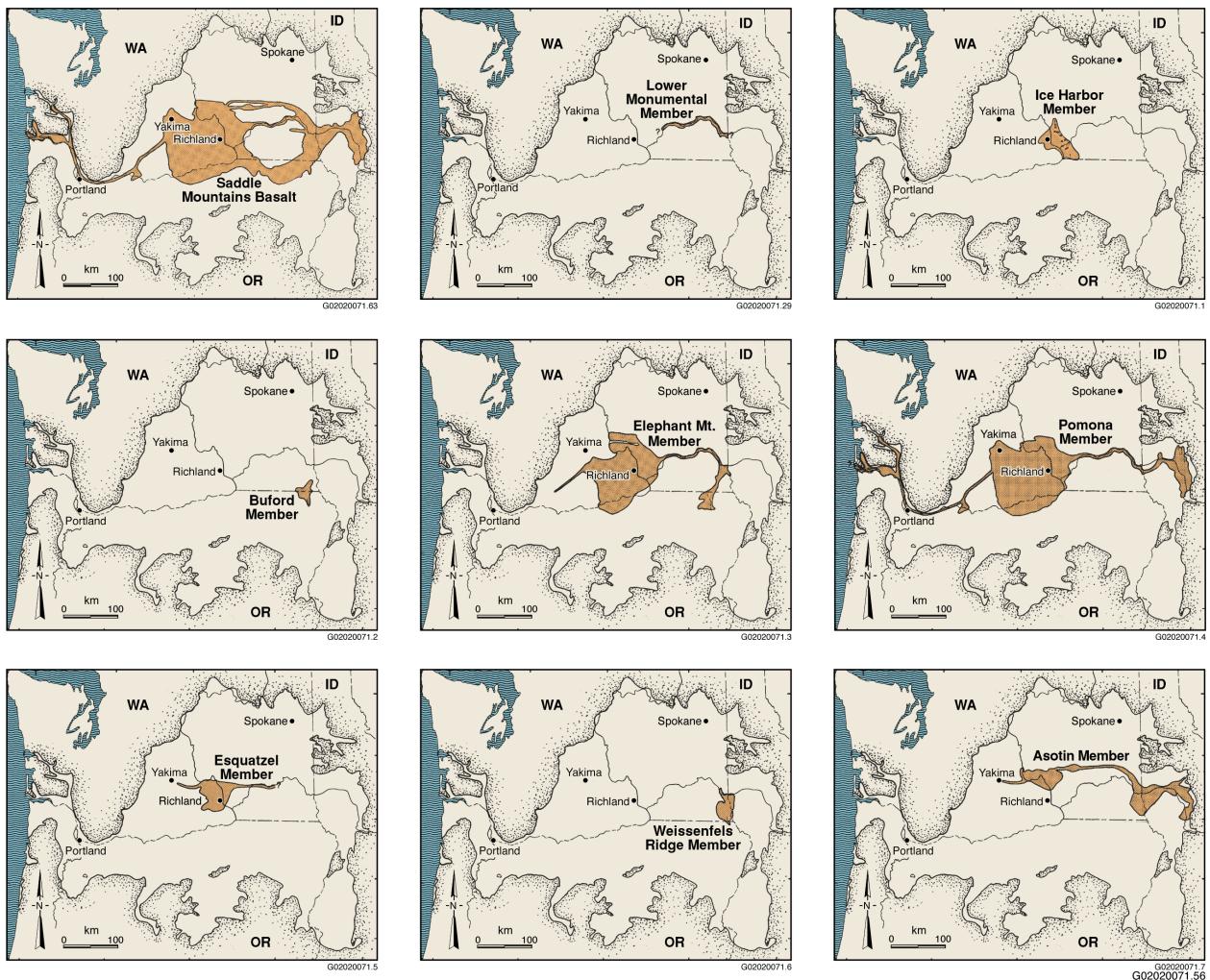
**Figure G.9.** Sr Versus Zr for Grande Ronde Basalt and Selected Flows of the Saddle Mountains Basalt



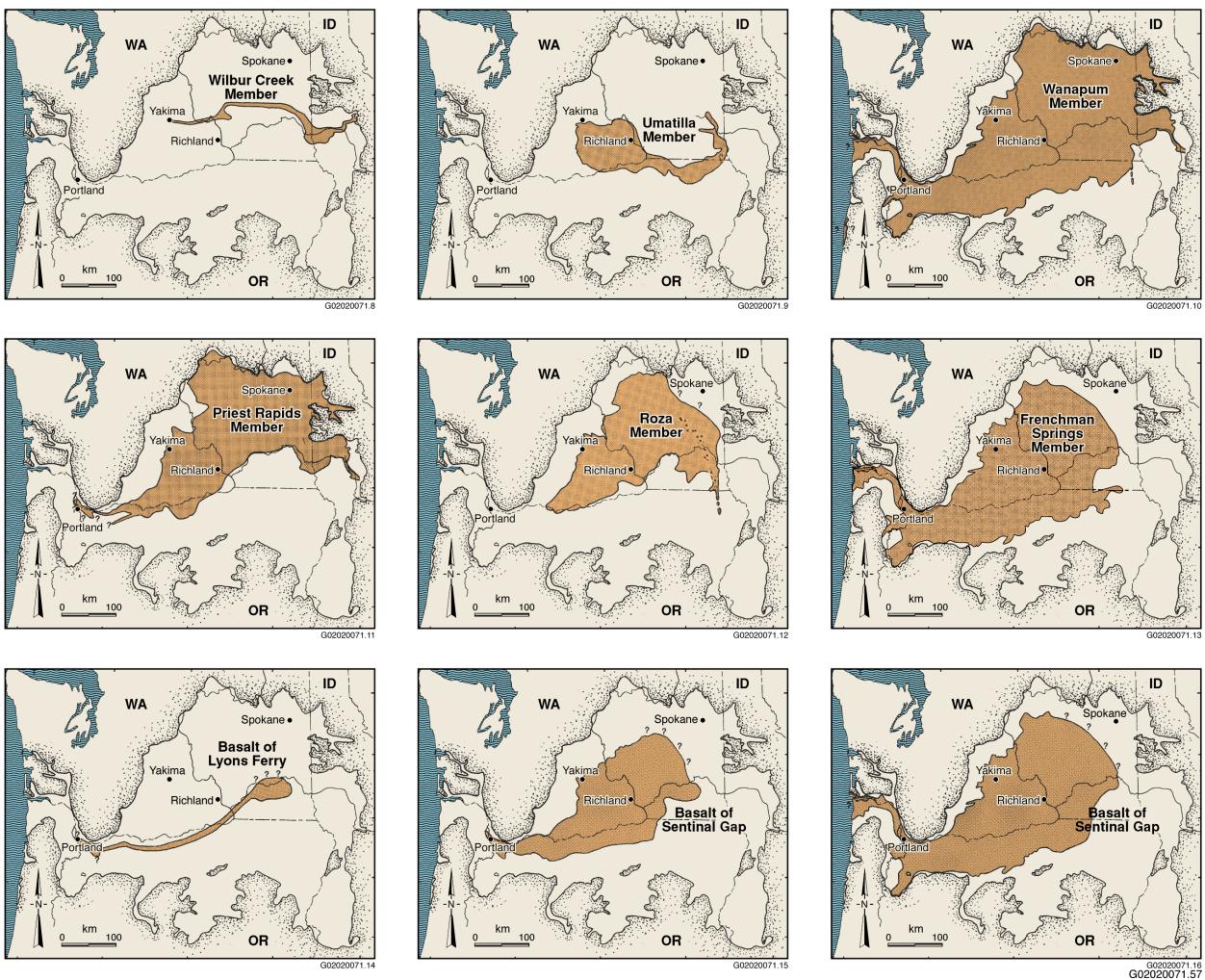
**Figure G.10.** Distribution of Columbia River Basalt Group Formations (see Figure G.1)



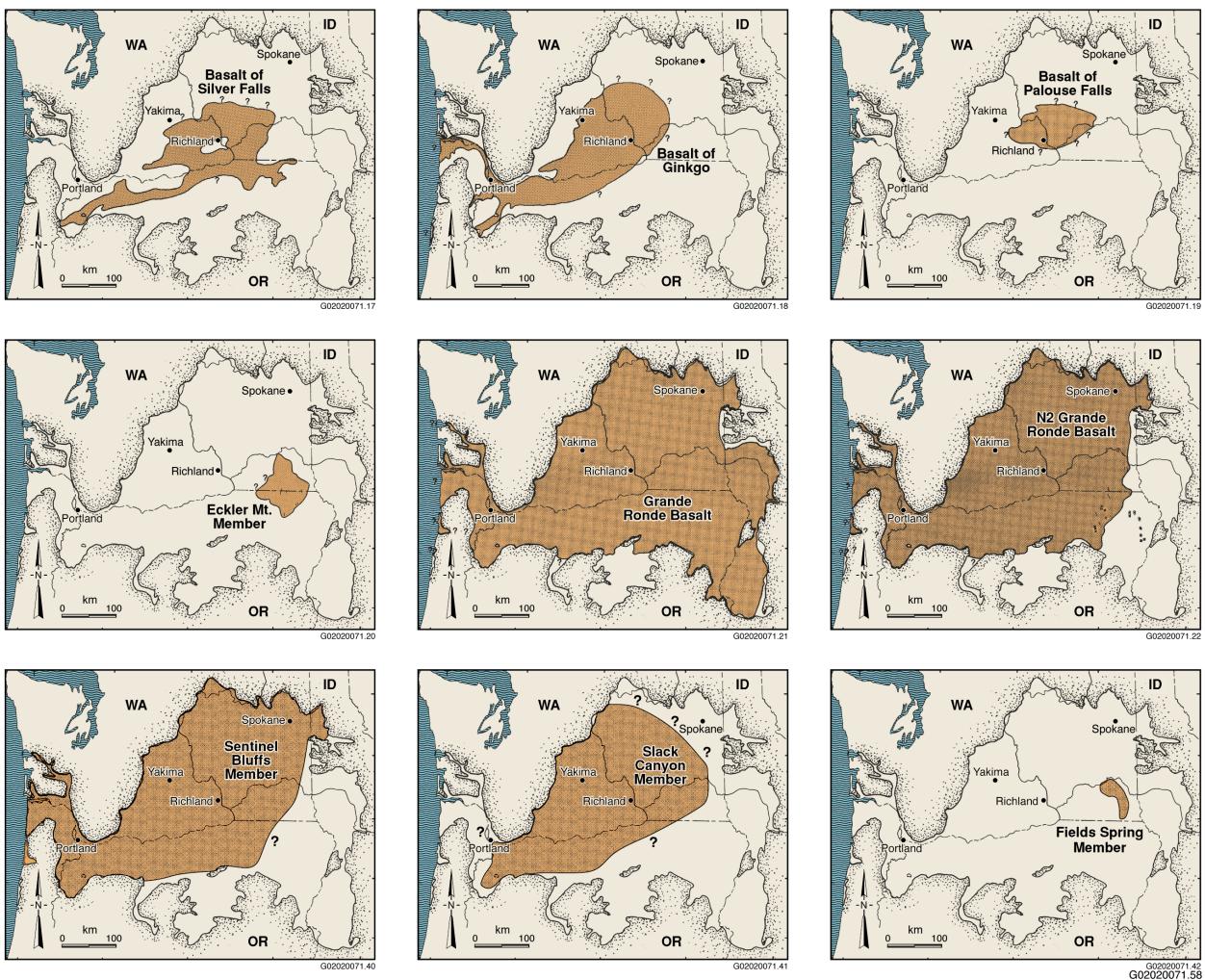
**Figure G.11.** Geologic Map of the Columbia River Basalt Group Showing Uppermost Lava Flows Distributed Across the Areal Extent of the Lava Flows



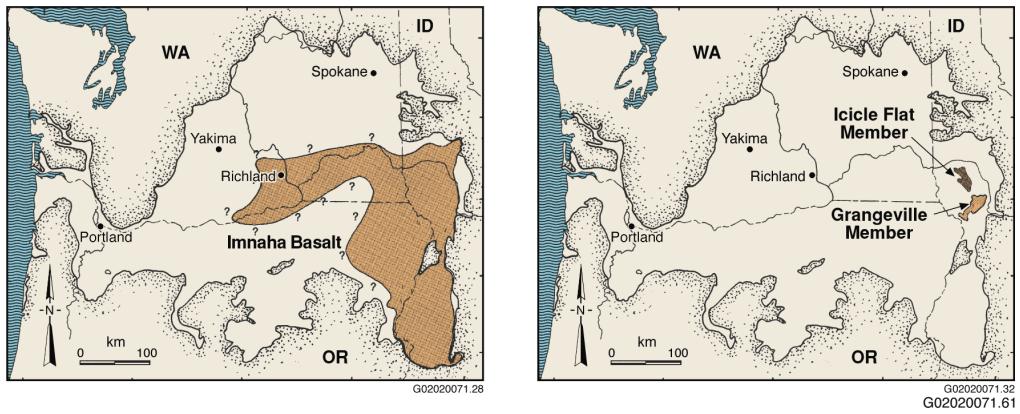
**Figure G.12.** Distribution Maps of Columbia River Basalt Group Flows (see Figure G.1 for nomenclature)



**Figure G.12.** (contd) Distribution Maps of Columbia River Basalt Group Flows (see Figure G.1 for nomenclature)



**Figure G.12.** (contd) Distribution Maps of Columbia River Basalt Group Flows (see Figure G.1 for nomenclature)



**Figure G.12.** (contd) Distribution Maps of Columbia River Basalt Group Flows (see Figure G.1 for nomenclature)

**Table G.1.** Chemical Composition of Columbia River Basalt Group Flows (see Figure G.1 for Nomenclature)

Formation	Unit Ident.	Major Oxides (weight per cent)										Trace Elements (ppm)													
		SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO*	MnO	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	TOTAL	Ni	Cr	Sc	V	Rb	Ba	Sr	Zr	Y	Nb	Cu	Zn	Ga
SMB	Lower Monumental	51.26	2.682	13.94	12.84	0.215	9.10	5.43	1.05	2.89	0.601	100.01	29	76	37	347	25	527	315	190	42	26.5	17	124	27
SMB	Lower Monumental	51.09	2.742	13.79	13.24	0.214	9.11	5.27	1.10	2.83	0.614	100.00	25	72	39	352	32	528	323	190	43	24.6	16	119	22
SMB	Lower Monumental	51.48	2.943	14.03	13.17	0.213	8.80	4.40	1.50	2.79	0.669	100.01	17	25	28	320	33	525	355	178	38	31.2	7	130	23
SMB	Ice Harbor, basalt of Goose Island	47.85	3.809	11.83	16.99	0.280	9.06	4.32	1.28	2.71	1.859	99.99	8	29	43	207	23	816	248	460	107	55.3	4	222	25
SMB	Ice Harbor, basalt of Goose Island	47.98	3.703	11.54	17.69	0.288	8.76	4.18	1.34	2.70	1.824	99.99	13	32	41	210	25	870	237	483	110	56.2	8	224	24
SMB	Ice Harbor, basalt of Martindale	48.40	3.376	13.35	14.28	0.211	10.42	6.07	0.51	2.62	0.767	99.99	33	181	44	360	5	496	253	246	55	28.4	37	147	25
SMB	Ice Harbor, basalt of Martindale	48.50	3.390	13.07	14.71	0.215	10.18	5.81	0.69	2.64	0.812	99.99	26	171	40	356	10	512	250	254	57	29.8	34	150	20
SMB	Ice Harbor, basalt of Martindale	48.67	3.380	13.08	14.54	0.221	10.06	5.84	0.78	2.58	0.831	99.99	32	163	42	350	14	543	249	265	58	30.4	35	158	24
SMB	Ice Harbor, basalt of Martindale	48.57	3.301	13.10	14.76	0.228	9.99	5.82	0.84	2.57	0.808	99.99	30	174	43	347	14	496	245	257	58	29.9	30	152	22
SMB	Ice Harbor, basalt of Martindale	48.59	3.349	13.21	14.24	0.222	10.30	6.03	0.66	2.62	0.776	99.99	25	176	40	358	10	493	248	248	56	28.4	32	149	23
SMB	Ice Harbor, basalt of Martindale	48.60	3.350	13.19	14.36	0.219	10.07	6.09	0.78	2.58	0.768	99.99	28	180	44	349	13	494	247	249	55	29.4	26	149	18
SMB	Ice Harbor, basalt of Basin City	49.29	3.560	12.82	14.78	0.222	9.49	5.21	1.01	2.74	0.880	99.99	20	109	45	364	20	635	251	289	62	32.4	23	156	23
SMB	Ice Harbor, basalt of Basin City	49.36	3.612	13.00	14.46	0.211	9.63	5.12	1.00	2.72	0.891	99.99	13	108	40	369	17	714	259	289	63	33.1	26	160	22
SMB	Buford	54.42	2.070	14.05	11.58	0.188	8.46	4.73	1.37	2.82	0.305	99.99	20	51	31	298	45	472	226	198	40	22.0	47	113	24
SMB	Buford	54.65	2.098	14.29	10.96	0.185	8.57	4.72	1.54	2.66	0.328	100.00	20	58	31	295	46	675	228	200	43	23.0	56	119	24
SMB	Buford	54.69	2.068	14.02	11.58	0.166	8.16	4.83	1.47	2.71	0.312	100.01	18	45	30	295	44	386	210	193	41	24.7	29	104	22
SMB	Elephant Mtn.	52.14	3.484	12.86	14.70	0.215	8.56	4.10	1.12	2.26	0.552	99.99	11	21	34	393	31	471	235	234	53	29.4	7	147	22
SMB	Elephant Mtn.	51.51	3.381	13.18	14.79	0.219	8.53	4.13	1.28	2.43	0.530	99.98	10	34	33	398	32	452	234	238	46	28.0	41	161	23
SMB	Elephant Mtn.	51.43	3.505	13.23	14.36	0.206	8.70	4.02	1.40	2.60	0.555	100.01	14	41	33	399	32	573	243	246	50	29.0	48	159	24
SMB	Elephant Mtn.	51.62	3.480	12.98	14.59	0.212	8.52	4.33	1.19	2.54	0.538	100.00	14	41	33	386	34	448	231	240	48	29.0	31	155	19
SMB	Elephant Mtn.	52.55	3.622	13.48	12.89	0.202	8.94	3.93	1.27	2.54	0.566	99.99	17	31	41	425	33	488	247	240	53	28.5	19	150	22
SMB	Elephant Mtn.	51.59	3.538	13.20	14.69	0.208	8.65	3.93	1.11	2.53	0.550	100.00	12	34	35	418	31	426	239	236	50	28.7	13	148	20
SMB	Elephant Mtn.	51.54	3.500	13.59	13.14	0.187	10.38	3.33	1.06	2.73	0.543	100.00	2	26	41	401	27	2107	317	240	48	27.5	8	148	24
SMB	Elephant Mtn.	51.78	3.690	12.92	14.43	0.203	8.74	3.72	1.30	2.64	0.570	99.99	8	22	38	427	30	478	241	255	53	28.0	6	155	27
SMB	Elephant Mtn.	51.37	3.580	12.78	14.77	0.213	8.53	4.22	1.33	2.65	0.563	100.01	4	25	37	414	33	460	230	253	51	29.2	12	154	26
SMB	Pomona	54.90	1.606	14.51	10.41	0.168	9.93	6.41	0.81	2.53	0.240	101.51	36	93	25	266	21	277	234	138	31	13.3	47	95	20
SMB	Pomona	53.20	1.635	14.51	10.61	0.175	10.43	6.90	0.73	2.48	0.229	100.90	40	99	27	278	16	245	228	135	29	14.4	49	97	19
SMB	Pomona	54.39	1.694	14.19	10.90	0.192	8.68	4.70	1.15	3.01	0.287	99.19	15	50	36	301	33	500	308	157	34	13.6	28	112	19
SMB	Pomona	53.02	1.693	15.28	9.30	0.176	11.86	5.34	0.73	2.36	0.234	99.99	41	112	38	295	19	620	240	136	30	15.5	55	94	20
SMB	Weis. R., Slip.Cr.	52.46	2.491	14.27	11.47	0.190	9.67	5.26	0.90	2.83	0.455	100.00	23	47	34	334	24	731	266	173	38	22.0	67	124	20

**Table G.1.** (contd)

Formation	Unit Ident.	Major Oxides (weight per cent)										Trace Elements (ppm)													
		SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO*	MnO	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	TOTAL	Ni	Cr	Sc	V	Rb	Ba	Sr	Zr	Y	Nb	Cu	Zn	Ga
SMB	Wilbur Creek	55.20	1.863	14.67	10.46	0.157	8.29	4.28	1.74	2.79	0.538	100.00	32	42	33	267	40	833	277	224	43	19.7	19	117	20
SMB	Wilbur Creek	54.37	1.895	14.29	11.48	0.191	8.41	4.32	1.88	2.65	0.517	100.00	29	32	31	270	39	869	277	222	43	19.9	20	116	21
SMB	Wilbur Creek	54.60	1.875	14.63	11.06	0.170	8.41	4.34	1.71	2.71	0.502	100.00	29	36	33	278	40	878	283	228	44	20.4	22	119	22
SMB	Esquatzel	54.40	3.026	13.26	13.34	0.188	7.62	3.84	1.65	3.00	0.408	100.73	3	13	19	347	47	576	258	208	40	24.8	9	128	24
SMB	Esquatzel	53.81	3.083	13.09	13.61	0.192	7.54	3.81	1.71	3.02	0.408	100.27	0	14	21	365	44	591	257	212	43	24.8	14	303	23
SMB	Umatilla, basalt of Sillusi.	56.16	2.870	14.55	9.97	0.216	6.62	1.89	2.93	3.76	1.030	100.00	1	11	30	155	48	3785	297	482	58	25.5	11	139	23
SMB	Umatilla, basalt of Sillusi.	54.50	2.810	13.80	12.32	0.320	6.48	2.59	2.82	3.41	0.960	100.01	2	12	27	168	45	3513	288	442	52	24.9	2	135	25
SMB	Umatilla, basalt of Sillusi.	55.52	2.640	13.98	11.96	0.196	5.75	2.26	2.77	3.89	1.040	100.01	0	13	27	133	51	3808	282	447	87	25.3	8	147	23
SMB	Umatilla, basalt of Sillusi.	55.23	2.604	13.74	12.13	0.185	5.93	2.64	2.76	3.78	1.010	100.01	0	19	26	135	47	3513	268	439	51	23.7	2	137	21
SMB	Umatilla, basalt of Sillusi.	57.07	2.939	15.08	8.87	0.158	6.65	1.82	3.03	3.30	1.084	100.00	9	15	31	197	48	3770	311	460	55	27.5	4	137	22
SMB	Umatilla, basalt of Sillusi.	55.27	2.689	14.01	11.96	0.229	6.45	2.35	2.80	3.26	0.990	100.01	2	13	28	171	48	3432	288	444	51	27.2	6	128	22
SMB	Umatilla, basalt of Sillusi.	54.34	3.094	13.83	11.86	0.238	7.44	2.56	2.55	3.24	0.843	100.00	0	10	31	244	44	2810	286	392	48	24.6	5	126	21
SMB	Umatilla, basalt of Sillusi.	57.59	2.678	14.65	10.16	0.107	5.67	1.51	2.96	3.60	1.073	100.00	6	16	31	143	48	3756	294	475	50	27.5	5	127	23
SMB	Umatilla, basalt of Sillusi.	56.19	2.975	14.33	10.68	0.167	6.49	2.17	2.61	3.50	0.912	100.02	14	23	30	217	46	3195	306	423	51	26.0	6	129	21
SMB	Umatilla, basalt of Sillusi.	57.02	2.730	14.34	10.61	0.156	5.70	1.51	2.98	3.86	1.100	100.01	0	0	31	146	50	3758	290	491	55	25.9	0	148	22
SMB	Umatilla, basalt of Sillusi.	54.72	2.670	13.63	12.12	0.195	6.51	2.73	2.89	3.56	0.970	100.00	0	8	30	147	50	3401	282	449	51	24.2	7	132	21
SMB	Umatilla, basalt of Sillusi.	55.45	2.700	13.77	11.98	0.172	6.27	2.33	2.65	3.69	0.980	99.99	0	10	31	153	39	3475	283	452	51	24.0	2	134	22
SMB	Umatilla, basalt of Sillusi.	55.35	2.589	13.82	11.91	0.162	6.27	2.29	2.81	3.78	1.030	100.01	0	14	31	139	36	3641	289	464	52	25.7	0	133	22
SMB	Umatilla, basalt of Umatilla	54.12	3.040	13.56	12.71	0.185	6.52	2.99	2.44	3.60	0.830	100.00	0	12	35	224	44	2833	273	406	48	23.8	7	130	22
SMB	Umatilla, basalt of Umatilla	54.29	3.070	13.65	12.31	0.182	6.59	2.97	2.45	3.64	0.830	99.98	0	12	31	233	45	2839	273	405	48	22.8	8	134	22
SMB	Umatilla, basalt of Umatilla	53.55	3.160	13.53	13.12	0.300	6.84	2.87	2.60	3.24	0.790	100.00	0	14	33	2	46	2731	286	395	48	23.8	3	130	22
SMB	Umatilla, basalt of Umatilla	53.81	3.130	13.51	12.78	0.201	6.75	3.18	2.59	3.28	0.780	100.01	5	19	29	252	48	2743	280	408	49	23.8	4	131	22
SMB	Umatilla, basalt of Umatilla	53.94	3.120	13.75	12.54	0.188	6.68	2.98	2.43	3.56	0.810	100.00	0	13	30	245	43	2849	279	412	49	24.1	5	139	21
SMB	Umatilla, basalt of Umatilla	53.83	3.190	13.82	12.45	0.208	6.89	2.90	2.48	3.43	0.800	100.00	0	15	33	250	43	2855	286	417	49	23.3	5	138	25
SMB	Umatilla, basalt of Umatilla	53.14	3.180	13.84	13.10	0.250	6.69	3.08	2.36	3.54	0.810	99.99	0	16	27	255	38	2883	280	411	48	23.3	4	137	23
SMB	Umatilla, basalt of Umatilla	54.60	2.990	13.65	12.38	0.175	6.51	2.75	2.45	3.66	0.830	100.00	0	13	29	214	42	2965	272	431	48	23.9	5	132	22
SMB	Umatilla, basalt of Umatilla	53.74	3.080	13.41	13.05	0.204	6.68	3.11	2.46	3.48	0.780	99.99	0	16	33	236	44	2767	275	402	46	23.7	7	127	23
SMB	Umatilla, basalt of Umatilla	53.31	3.190	13.52	12.98	0.199	6.89	3.32	2.45	3.38	0.770	100.01	0	12	30	265	42	2670	279	389	47	23.7	6	130	23
SMB	Umatilla, basalt of Umatilla	53.98	3.130	13.70	12.24	0.192	6.66	3.29	2.38	3.62	0.810	100.00	0	14	31	229	42	2773	266	394	47	23.6	6	127	21
SMB	Umatilla, basalt of Umatilla	54.03	3.430	15.04	10.83	0.155	6.96	2.59	2.27	3.79	0.900	100.00	1	13	32	256</									

**Table G.1.** (contd)

Formation	Unit Ident.	Major Oxides (weight per cent)										Trace Elements (ppm)													
		SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO*	MnO	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	TOTAL	Ni	Cr	Sc	V	Rb	Ba	Sr	Zr	Y	Nb	Cu	Zn	Ga
WB	Priest Rapids, basalt of Lolo	50.18	3.201	13.29	14.19	0.234	9.35	5.12	1.14	2.53	0.776	100.01	34	97	43	361	25	426	288	176	47	18.6	49	143	22
WB	Priest Rapids, basalt of Lolo	51.16	3.212	13.91	12.79	0.209	9.64	4.48	1.13	2.69	0.783	100.00	48	110	36	388	28	593	299	178	47	19.0	37	137	23
WB	Priest Rapids, basalt of Lolo	50.79	3.206	13.81	13.31	0.212	9.44	4.78	1.12	2.54	0.784	99.99	39	102	37	359	23	650	298	179	47	19.8	38	137	24
WB	Priest Rapids, basalt of Lolo	50.94	3.211	13.79	12.81	0.209	9.59	4.90	1.12	2.63	0.796	100.00	31	95	41	378	25	588	302	180	49	18.3	38	132	22
WB	Priest Rapids, basalt of Lolo	50.55	3.161	13.37	13.70	0.233	9.20	5.20	1.09	2.72	0.772	100.00	50	110	39	372	24	473	288	175	44	18.0	36	135	23
WB	Priest Rapids, basalt of Rosalia	50.40	3.533	12.97	14.82	0.239	8.91	4.36	1.11	2.87	0.820	100.03	7	25	44	427	21	606	301	223	55	19.3	25	163	21
WB	Priest Rapids, basalt of Rosalia	49.99	3.595	12.74	14.85	0.242	9.32	4.61	1.13	2.87	0.763	100.11	6	25	42	406	25	567	291	207	51	19.4	25	171	8
WB	Priest Rapids, basalt of Rosalia	49.82	3.300	14.15	12.67	0.210	10.31	4.83	1.10	2.83	0.770	99.99	27	97	44	364	23	483	310	179	43	17.1	27	129	24
WB	Priest Rapids, basalt of Rosalia	50.25	3.88	13.34	15.12	0.30	9.52	3.98	0.46	2.26	0.89	100.00	0	24	36	426	13	317	245	264	61	27.5	7	147	23
WB	Priest Rapids, basalt of Rosalia	49.90	3.310	13.40	14.33	0.250	9.26	4.97	0.98	2.78	0.810	99.99	30	87	43	367	24	625	314	187	46	17.1	31	134	24
WB	Priest Rapids, basalt of Rosalia	50.32	3.290	13.70	13.80	0.220	9.43	4.67	1.07	2.71	0.780	99.99	29	90	44	361	26	587	302	184	46	17.1	31	143	20
WB	Priest Rapids, basalt of Rosalia	50.13	3.260	13.71	13.59	0.220	9.36	4.96	1.09	2.89	0.790	100.00	30	94	44	352	23	501	298	183	44	16.7	30	140	24
WB	Priest Rapids, basalt of Rosalia	50.70	3.26	13.76	12.89	0.213	9.40	5.01	1.18	2.81	0.79	100.00	37	100	41	359	24	470	291	182	43	19.4	33	145	22
WB	Roza	51.10	3.270	13.43	13.94	0.224	8.65	4.40	1.32	2.95	0.710	99.99	10	36	38	406	33	545	307	191	42	16.6	13	143	24
WB	Roza	51.19	3.240	13.31	14.20	0.222	8.52	4.39	1.43	2.79	0.700	99.99	7	35	43	416	34	576	308	191	44	16.1	16	139	23
WB	Roza	51.07	3.260	13.35	14.13	0.228	8.56	4.43	1.34	2.94	0.700	100.01	6	33	47	412	32	553	305	191	43	16.5	19	138	22
WB	Roza	51.01	3.280	13.42	13.97	0.240	8.84	4.20	1.49	2.83	0.720	100.00	8	31	42	424	34	544	309	191	42	16.3	19	143	25
WB	Roza	52.02	3.264	13.82	12.56	0.494	8.93	4.01	1.29	2.88	0.732	100.00	36	56	40	433	31	688	332	192	47	17.6	26	139	26
WB	Roza	51.23	3.310	13.53	13.58	0.222	8.77	4.30	1.35	2.99	0.730	100.01	10	33	41	431	30	613	317	198	47	17.3	25	146	24
WB	Roza	52.69	3.296	13.90	12.46	0.211	8.87	3.67	1.43	2.73	0.732	99.99	16	43	43	428	33	546	319	191	45	19.3	30	143	23
WB	Roza	51.29	3.196	13.42	14.73	0.199	8.64	4.13	1.09	2.62	0.689	100.00	17	47	40	392	27	560	315	185	45	17.3	23	132	21
WB	Roza	50.24	3.099	13.62	13.80	0.231	9.19	5.53	0.98	2.59	0.721	100.00	56	123	42	356	20	484	288	161	42	17.0	27	129	19
WB	Roza	52.01	3.160	13.59	13.60	0.209	8.59	4.02	1.27	2.84	0.701	99.99	28	58	39	424	29	561	313	186	45	17.7	26	136	23
WB	Roza	52.09	3.243	13.78	13.42	0.211	8.83	3.85	1.26	2.60	0.713	100.00	12	44	39	433	34	515	329	187	48	19.7	29	136	22
WB	Roza	52.14	3.239	13.98	12.83	0.193	8.94	3.94	1.28	2.75	0.708	100.00	13	40	42	432	30	659	324	188	46	19.1	24	135	20
WB	Roza	51.49	3.142	13.48	13.94	0.226	8.56	4.37	1.47	2.61	0.704	99.99	16	44	40	410	30	509	308	183	45	20.2	24	132	22
WB	Roza	51.73	3.026	13.85	13.24	0.221	8.98	4.21	1.27	2.85	0.632	100.01	25	72	40	400	29	504	311	177	43	17.7	43	143	16
WB	Roza	51.31	3.147	13.14	14.49	0.233	8.63	4.21	1.48	2.67	0.700	100.01	19	49	38	418	32	587	310	185	45	18.2	34	136	22
WB	Roza	51.53	3.148	13.34	14.00	0.223	8.71	4.27	1.45	2.60	0.727	100.00	19	46	38	421	33	543	307	183	44	17.8	23	137	26
WB	Fr.Spr., basalt of Lyns.F.	52.24	3.13	13.22	14.22	0.201	8.07	4.05	1.34	2.92	0.61	100.00	0	26	47	462	41	545	310	192	41	15.3	44	160	20
WB	Fr.Spr., basalt of Lyn																								

**Table G.1.** (contd)

Formation	Unit Ident.	Major Oxides (weight per cent)											Trace Elements (ppm)												
		SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO*	MnO	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	TOTAL	Ni	Cr	Sc	V	Rb	Ba	Sr	Zr	Y	Nb	Cu	Zn	Ga
WB	Fr.Spr., basalt of Sentinel Gap	51.80	3.124	13.13	14.41	0.211	8.18	4.11	1.31	3.08	0.642	100.00	0	24	40	422	29	579	308	191	42	16.2	6	140	22
WB	Fr.Spr., basalt of Sentinel Gap	52.01	3.164	13.37	13.71	0.244	8.41	4.02	1.37	3.05	0.637	99.99	6	29	43	442	34	649	318	203	46	17.1	15	153	22
WB	Fr.Spr., basalt of Sentinel Gap	52.16	3.124	13.21	14.03	0.211	8.22	4.03	1.33	3.06	0.637	100.01	1	27	38	447	30	570	309	191	41	17.7	8	144	22
WB	Fr.Spr., basalt of Sentinel Gap	51.61	3.114	13.25	14.14	0.227	8.26	4.26	1.58	2.92	0.640	100.00	2	24	44	434	37	563	312	190	42	15.7	11	141	23
WB	Fr.Spr., basalt of Sand Hollow	52.65	3.053	14.29	12.39	0.184	9.07	3.83	1.16	2.74	0.627	99.99	32	76	40	425	27	541	314	181	43	17.7	35	141	21
WB	Fr.Spr., basalt of Sand Hollow	52.62	3.165	14.76	11.64	0.177	9.33	3.73	1.11	2.83	0.632	99.99	19	74	41	452	30	521	339	185	45	18.7	25	131	24
WB	Fr.Spr., basalt of Sand Hollow	50.98	3.026	13.99	14.25	0.217	8.83	4.58	1.01	2.52	0.601	100.00	23	72	37	423	22	566	317	174	43	17.0	34	125	23
WB	Fr.Spr., basalt of Sand Hollow	51.55	2.944	13.90	13.68	0.215	8.73	4.51	1.32	2.55	0.598	100.00	16	62	39	406	30	519	311	172	42	17.9	23	127	21
WB	Fr.Spr., basalt of Sand Hollow	51.45	2.929	13.76	13.92	0.218	8.74	4.40	1.25	2.72	0.617	100.00	38	84	43	410	29	510	309	179	43	16.7	29	129	22
	Fr.Spr., basalt of Sand Hollow	52.01	2.955	13.40	13.84	0.219	8.41	4.56	1.28	3.07	0.564	100.31	12	57	39	418	33	575	314	181	41	15.6	23	138	18
	Fr.Spr., basalt of Sand Hollow	51.74	2.934	13.30	14.30	0.220	8.31	4.49	1.39	2.99	0.558	100.23	4	49	44	414	37	541	312	183	44	16.7	25	137	12
	Fr.Spr., basalt of Silver Falls	51.10	3.180	13.48	14.68	0.221	8.53	4.07	1.08	2.97	0.622	99.93	1	25	42	423	31	498	329	186	43	15.9	24	144	11
	Fr.Spr., basalt of Silver Falls	51.95	3.096	13.59	14.65	0.224	8.45	4.24	1.31	3.04	0.610	101.16	1	23	41	417	36	530	324	180	43	16.7	24	144	11
	Fr.Spr., basalt of Silver Falls	51.51	3.170	13.55	14.59	0.219	8.37	3.94	1.16	3.15	0.636	100.30	0	27	37	437	31	556	325	183	44	16.4	21	151	11
	Fr.Spr., basalt of Silver Falls	51.25	3.106	13.42	14.66	0.226	8.47	4.08	1.13	3.05	0.616	100.01	1	25	42	416	31	543	325	179	41	16.2	24	156	11
	Fr.Spr., basalt of Silver Falls	51.46	3.115	13.22	14.62	0.223	8.36	4.23	1.32	3.06	0.632	100.24	2	22	38	416	37	562	324	182	43	15.6	24	147	13
	Fr.Spr., basalt of Silver Falls	51.50	3.110	13.30	14.81	0.222	8.34	4.27	1.37	3.00	0.618	100.54	1	24	41	406	36	542	322	180	42	16.2	22	138	8
	Fr.Spr., Ginkgo	52.18	3.134	13.39	14.43	0.230	8.36	3.97	1.32	3.12	0.712	100.85	0	22	41	386	37	586	333	183	45	16.9	25	143	5
	Fr.Spr., Ginkgo	51.68	3.252	13.34	14.51	0.212	8.44	3.80	1.42	3.09	0.640	100.38	2	25	42	419	46	552	326	183	45	16.7	23	137	13
	Fr.Spr., Ginkgo	51.40	3.086	13.10	14.79	0.228	8.26	4.20	1.33	3.10	0.665	100.16	0	21	39	382	34	564	328	180	43	15.4	27	138	10
	Fr.Spr., Ginkgo	51.62	3.133	13.27	14.62	0.231	8.33	3.96	1.27	3.02	0.699	100.15	1	24	41	383	36	546	324	183	44	16.1	25	144	9
	Fr.Spr., Ginkgo	51.71	3.108	13.23	14.90	0.230	8.19	4.19	1.26	3.14	0.679	100.64	0	25	39	390	35	564	323	183	45	16.1	23	141	12
	Fr.Spr., Ginkgo	51.40	3.102	13.19	14.90	0.228	8.22	4.23	1.19	3.18	0.675	100.32	1	25	41	386	30	570	320	179	42	17.4	23	146	9
	Fr.Spr., basalt of Palouse Falls	51.29	3.125	13.17	14.36	0.236	8.56	4.25	0.93	3.10	0.537	99.56	12	43	45	386	22	494	301	163	43	14.9	23	142	20
	Fr.Spr., basalt of Palouse Falls	51.74	3.275	13.45	14.19	0.221	8.26	4.19	1.14	3.28	0.558	100.30	13	36	44	415	28	549	304	167	44	15.3	21	145	21
	Fr.Spr., basalt of Palouse Falls	52.16	3.195	13.51	14.21	0.244	8.11	4.01	1.14	3.27	0.552	100.40	11	38	42	391	29	535	303	173	46	15.0	22	141	17
WB	Eckler Mtn., Schumaker Creek	55.04	2.517	13.45	13.23	0.248	6.42	2.62	1.89	3.64	0.948	100.00	0	5	39	163	49	1040	331	244	66	22.7	12	168	23
WB	Eckler Mtn., Schumaker Creek	55.32	2.496	13.38	12.37	0.229	6.80	2.89	1.90	3.67	0.950	100.01	0	6	39	160	44	1021	327	245	66	21.7	5	159	24
WB	Eckler Mtn., Schumaker Creek	55.04	2.466	13.29	13.23	0.226	6.54	2.74	1.91	3.62	0.949	100.01	0	6	38	154	50	1015	328	248	65	23.1	9	157	24
WB	Eckler Mtn., Schumaker Creek	54.73	2.647	14.30	11.59	0.251	7.13	2.93	1.71	3.70	1.010	100.00	1	3	39	173	28	1156	356						

**Table G.1.** (contd)

Formation	Unit Ident.	Major Oxides (weight per cent)										Trace Elements (ppm)													
		SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO*	MnO	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	TOTAL	Ni	Cr	Sc	V	Rb	Ba	Sr	Zr	Y	Nb	Cu	Zn	Ga
GRB	Basalt of Sentinel Bluffs	55.89	14.61	1.673	11.05	0.187	4.91	8.40	3.14	1.22	0.285		289	35	10	50	160	105	32	21	11.4	32	521	32	303
GRB	Basalt of Sentinel Bluffs	54.49	14.42	1.665	11.36	0.197	5.07	9.03	2.98	0.99	0.272	100.47	312	37	10	52	149	102	30	19	10.6	28	412	30	309
GRB	Basalt of Sentinel Bluffs	54.49	14.42	1.665	11.36	0.197	5.07	9.03	2.98	0.99	0.272		312	37	10	52	149	102	30	19	10.6	28	412	30	309
GRB	Basalt of Sentinel Bluffs	54.32	14.57	1.698	11.30	0.194	5.28	9.04	3.15	0.99	0.270	100.81	311	38	8	51	150	107	33	20	12.1	22	426	28	309
GRB	Basalt of Sentinel Bluffs	55.27	15.06	1.659	11.26	0.199	5.06	8.84	3.03	0.96	0.278	101.62	304	37	10	54	150	103	31	19	11.4	38	503	17	312
GRB	Basalt of Sentinel Bluffs	55.27	15.06	1.659	11.26	0.199	5.06	8.84	3.03	0.96	0.278		304	37	10	54	150	103	31	19	11.4	38	503	17	312
GRB	Basalt of Sentinel Bluffs	54.50	14.86	1.691	11.22	0.195	5.12	8.81	3.34	0.96	0.271	100.97	319	37	8	53	151	109	34	24	11.3	24	481	16	313
GRB	Basalt of Sentinel Bluffs	55.28	14.73	1.725	11.62	0.199	4.89	8.71	2.96	1.14	0.302	101.56	293	33	8	45	156	111	29	23	10.7	32	511	35	315
GRB	Basalt of Sentinel Bluffs	54.70	14.54	1.758	11.57	0.194	4.92	8.69	3.25	1.14	0.302	101.06	317	34	3	46	157	114	34	22	12.2	18	522	32	313
GRB	Basalt of Sentinel Bluffs	54.93	14.41	1.758	11.36	0.192	4.99	8.59	3.26	1.21	0.310	101.01	310	36	2	43	157	113	35	24	14.3	19	509	31	308
GRB	Basalt of Sentinel Bluffs	55.23	14.34	1.721	11.37	0.198	4.77	8.57	3.05	1.21	0.318	100.78	300	35	11	49	156	112	31	22	14.0	27	488	33	308
GRB	Basalt of Sentinel Bluffs	55.51	14.60	1.722	11.49	0.197	4.85	8.61	2.93	1.22	0.311	101.44	303	35	11	47	154	110	32	19	11.7	37	507	33	310
GRB	Basalt of Sentinel Bluffs	55.02	14.29	1.753	11.39	0.194	4.89	8.56	3.12	1.23	0.318	100.77	309	30	10	48	156	111	33	21	11.7	18	503	33	308
GRB	Basalt of Sentinel Bluffs	55.14	14.18	1.819	11.50	0.195	4.57	8.42	3.20	1.22	0.353	100.60	289	37	2	41	163	117	36	22	12.7	19	562	32	310
GRB	Basalt of Sentinel Bluffs	55.32	14.41	1.786	11.59	0.197	4.52	8.44	3.07	1.22	0.348	100.90	285	35	8	42	161	110	33	21	13.8	31	550	34	310
GRB	Basalt of Sentinel Bluffs	54.42	14.34	1.833	11.73	0.196	5.08	8.92	3.10	1.01	0.289	100.92	341	39	5	48	154	109	34	22	12.2	22	438	29	310
GRB	Basalt of Sentinel Bluffs	55.02	14.64	1.800	11.79	0.200	5.01	8.94	2.94	1.01	0.285	101.64	308	35	12	49	152	107	31	24	10.8	29	434	29	310
GRB	Basalt of Sentinel Bluffs	54.49	14.17	1.745	11.81	0.204	4.90	8.83	3.08	1.04	0.283	100.55	323	37	9	50	153	107	31	24	11.8	29	458	33	310
GRB	Basalt of Sentinel Bluffs	54.87	14.21	1.798	11.73	0.200	4.97	8.80	3.09	1.04	0.287	101.00	333	39	9	44	152	110	32	23	11.4	28	426	33	309
GRB	Basalt of Sentinel Bluffs	54.27	14.28	1.776	11.64	0.192	5.10	8.99	3.09	0.97	0.278	100.59	338	39	8	51	149	108	32	20	12.5	26	407	29	310
GRB	Basalt of Sentinel Bluffs	54.28	14.29	1.739	11.75	0.197	5.07	9.00	3.06	0.97	0.273	100.63	317	36	10	54	149	108	30	21	12.0	39	419	30	310
GRB	Basalt of Sentinel Bluffs	54.75	13.99	1.877	11.92	0.202	4.83	8.56	3.13	1.18	0.362	100.80	288	38	8	46	160	119	36	20	12.7	21	470	34	306
GRB	Basalt of Sentinel Bluffs	54.47	14.02	1.833	11.96	0.207	4.77	8.59	3.07	1.18	0.361	100.46	289	35	9	43	160	109	33	23	12.4	28	471	36	307
GRB	Basalt of Sentinel Bluffs	54.08	14.09	1.764	11.55	0.202	5.13	8.88	3.03	1.13	0.276	100.13	312	38	14	59	150	104	33	22	9.9	36	425	29	304
GRB	Basalt of Sentinel Bluffs	54.69	14.07	1.789	11.53	0.196	5.16	8.86	2.97	1.13	0.284	100.68	331	39	8	52	150	110	33	20	12.0	28	429	28	301
GRB	Basalt of Sentinel Bluffs	55.34	14.33	1.847	11.58	0.193	4.74	8.70	3.16	1.19	0.294	101.37	338	45	6	40	154	109	33	21	12.0	29	481	30	311
GRB	Basalt of Sentinel Bluffs	54.41	14.20	1.798	11.68	0.198	4.62	8.71	3.13	1.19	0.292	100.23	331	37	10	45	154	110	32	25	12.9	32	456	30	315
GRB	Basalt of Sentinel Bluffs	55.03	14.26	1.820	11.64	0.195	4.85	8.75	3.20	1.14	0.288	101.17	318	35	8	44	153	109	33	21	11.6	29	445	29	307
GRB	Basalt of Sentinel Bluffs	54.45	14.26	1.792	11.74	0.197	4.77	8.76	3.15	1.13	0.285	100.53	323	37	10	53	152	105	31	20	12.5	34	438	30	308
GRB	Basalt of Sentinel Bluffs	54.62	14.38	1.776	11.43	0.206	5.11	8.86	3.11	1.09	0.297	100.88	306	34	15	51	149	107	31	19	11.0	35	476	2	

**Table G.1.** (contd)

Formation	Unit Ident.	Major Oxides (weight per cent)										Trace Elements (ppm)													
		SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO*	MnO	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	TOTAL	Ni	Cr	Sc	V	Rb	Ba	Sr	Zr	Y	Nb	Cu	Zn	Ga
GRB	Basalt of Sentinel Bluffs	54.45	13.74	1.960	12.12	0.206	4.63	8.33	3.15	1.14	0.307	100.03	341	36	1	25	156	122	34	24	12.1	18	458	31	312
GRB	Basalt of Sentinel Bluffs	54.18	13.75	1.922	12.20	0.210	4.51	8.35	3.10	1.14	0.302	99.66	337	37	4	25	155	114	32	21	11.6	29	453	33	311
GRB	Basalt of Umtanum	55.52	13.52	2.147	12.72	0.214	3.40	7.15	3.37	1.63	0.378	100.05	324	31	0	19	178	124	36	23	14.1	12	596	48	309
GRB	Basalt of Umtanum	55.79	13.45	2.191	12.64	0.210	3.43	7.17	3.38	1.62	0.384	100.27	325	33	0	12	180	132	40	24	14.6	0	608	45	308
GRB	Basalt of Umtanum	56.02	13.43	2.162	12.55	0.205	3.40	7.10	3.43	1.56	0.385	100.24	324	35	0	17	179	131	38	21	13.3	3	615	45	310
GRB	Basalt of Umtanum	55.74	13.33	2.131	12.65	0.210	3.35	7.09	3.36	1.57	0.382	99.81	321	32	4	16	178	124	37	22	15.0	5	588	45	312
GRB	Basalt of Umtanum	55.53	13.35	2.286	12.94	0.210	3.39	7.15	3.47	1.45	0.390	100.17	315	31	2	18	183	133	39	23	14.9	0	614	49	308
GRB	Basalt of Umtanum	55.46	13.43	2.224	13.02	0.216	3.35	7.17	3.48	1.45	0.386	100.19	297	33	3	18	180	125	37	19	13.7	9	583	48	312
GRB	Basalt of Fields Spring	53.43	1.169	15.22	9.76	0.176	10.28	6.25	0.54	2.92	0.262	100.01	17	101	45	283	11	404	395	123	26	8.0	57	92	21
GRB	Basalt of Fields Spring	54.14	1.154	15.02	9.15	0.226	10.19	6.19	0.76	2.91	0.266	100.01	15	94	51	264	16	422	388	122	25	7.3	48	95	17
GRB	Basalt of Fields Spring	53.10	1.098	15.27	9.46	0.172	10.61	6.57	0.52	2.94	0.250	99.99	21	100	45	255	10	355	391	114	24	7.5	68	88	18
GRB	Basalt of Fields Spring	53.86	1.175	14.83	9.62	0.183	10.16	6.15	0.80	2.95	0.273	100.00	18	95	47	264	16	466	388	124	26	7.9	52	91	20
GRB	Basalt of Fields Spring	53.86	1.128	14.93	9.41	0.172	10.26	6.27	0.75	2.95	0.275	100.01	20	95	45	267	15	456	389	117	25	7.5	47	89	17
GRB	Basalt of Fields Spring	53.65	1.135	15.15	9.36	0.170	10.35	6.31	0.69	2.92	0.260	100.00	18	96	48	263	14	410	387	116	25	7.2	116	93	18
GRB	Basalt of Fields Spring	53.63	1.104	15.10	9.36	0.172	10.39	6.41	0.67	2.91	0.240	99.99	18	99	48	257	13	362	388	112	24	6.6	52	90	21
GRB	Basalt of Fields Spring	53.97	1.163	14.82	9.60	0.182	10.01	6.14	0.76	3.09	0.270	100.01	15	90	46	265	14	422	383	119	25	7.6	64	95	18
GRB	Basalt of Fields Spring	53.77	1.191	14.96	9.67	0.178	10.03	6.13	0.79	3.02	0.270	100.01	19	88	43	264	16	433	387	120	25	7.9	49	88	16
GRB	Basalt of Fields Spring	54.08	1.118	15.01	9.07	0.172	10.20	6.29	0.82	2.99	0.257	100.01	17	91	44	266	17	417	388	118	24	8.5	51	86	16
GRB	Basalt of Fields Spring	53.83	1.114	15.10	9.17	0.172	10.26	6.35	0.73	3.02	0.254	100.00	18	96	41	273	15	368	385	116	25	7.8	36	92	21
GRB	Basalt of Fields Spring	54.16	1.152	14.91	9.55	0.181	10.06	6.12	0.77	2.84	0.271	100.01	22	93	39	267	18	550	388	122	29	9.0	65	91	17
GRB	Basalt of Fields Spring	54.00	1.189	15.07	9.43	0.196	10.06	6.07	0.78	2.93	0.277	100.00	22	99	38	247	16	489	384	125	26	9.0	61	95	20
GRB	Basalt of Fields Spring	53.81	1.216	15.02	9.56	0.240	10.10	6.02	0.70	3.04	0.283	99.99	15	87	46	276	16	403	391	127	28	7.7	46	96	21
GRB	Basalt of Fields Spring	54.22	1.174	14.96	9.37	0.174	10.23	5.84	0.84	2.91	0.273	99.99	13	95	42	260	17	410	387	123	26	7.9	62	92	22
GRB	Basalt of Fields Spring	53.50	1.164	15.09	9.96	0.174	10.18	6.13	0.60	2.95	0.267	100.02	18	89	51	261	15	339	388	120	24	7.4	33	81	17
GRB	Basalt of Fields Spring	53.50	1.152	15.10	9.57	0.174	10.35	6.21	0.72	2.97	0.267	100.01	17	92	47	257	15	656	411	120	27	6.6	39	88	18
GRB	Basalt of Fields Spring	54.09	1.232	14.99	9.91	0.180	9.81	5.70	0.79	2.99	0.330	100.00	17	88	43	275	17	433	380	134	27	9.4	19	90	19
GRB	Basalt of Fields Spring	53.80	1.185	15.17	9.70	0.170	10.28	5.89	0.65	2.88	0.267	99.99	15	94	44	265	14	372	398	124	27	9.4	37	91	21
GRB	Basalt of Fields Spring	54.10	1.184	14.94	9.28	0.181	10.02	5.96	1.09	2.97	0.276	100.00	14	83	47	253	22	456	386	125	26	7.9	53	92	18
GRB	Basalt of Fields Spring	53.21	1.238	15.67	10.27	0.185	10.32	5.41	0.46	2.95	0.288	100.00	11	93	47	264	9	347	412	130	29	9.0	51	92	20
GRB	Basalt of Fields Spring	54.20	1.187	14.80	9.21	0.185	9.93	6.15	1.17	2.89	0.277	100.00	16	86	45	268	21	388	372	123	27	8.6	51	91	17
GRB	Basalt of Fields Spring	54.37</																							

**Table G.1.** (contd)

Formation	Unit Ident.	Major Oxides (weight per cent)										Trace Elements (ppm)													
		SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO*	MnO	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	TOTAL	Ni	Cr	Sc	V	Rb	Ba	Sr	Zr	Y	Nb	Cu	Zn	Ga
GRB	Basalt of Meyer Ridge	53.34	1.650	14.45	11.25	0.186	9.42	5.42	1.01	3.02	0.261	100.01	20	106	41	310	23	427	308	137	29	11.5	71	102	21
GRB	Basalt of Meyer Ridge	53.36	1.591	14.56	10.86	0.193	9.60	5.60	0.95	3.04	0.248	100.00	23	114	42	319	23	404	313	132	29	11.3	59	99	20
GRB	Basalt of Meyer Ridge	52.57	1.673	14.42	11.34	0.197	10.04	5.60	0.85	3.03	0.281	100.00	15	119	45	348	15	410	371	127	28	9.0	42	111	19
GRB	Basalt of Meyer Ridge	52.20	1.683	14.48	11.65	0.196	9.83	5.74	0.67	3.27	0.266	99.99	13	122	41	352	11	402	369	117	30	10.2	45	107	19
GRB	Basalt of Meyer Ridge	53.44	1.656	14.76	10.67	0.191	9.58	5.53	0.89	3.02	0.259	100.00	23	110	41	328	22	614	329	136	29	11.2	45	103	20
GRB	Basalt of Meyer Ridge	53.59	1.547	14.74	10.63	0.169	9.70	5.68	0.83	2.88	0.244	100.01	45	144	37	307	18	373	318	129	29	11.0	76	97	16
GRB	Basalt of Meyer Ridge	53.43	1.530	14.94	10.68	0.205	9.64	5.80	0.97	2.57	0.241	100.01	39	150	35	294	25	531	319	128	32	11.0	90	104	20
GRB	Basalt of Meyer Ridge	53.80	1.616	14.54	11.26	0.199	9.10	5.21	1.06	2.95	0.265	100.00	31	125	34	309	31	461	305	138	32	12.0	72	107	16
GRB	Basalt of Meyer Ridge	54.18	1.628	14.76	10.36	0.225	9.55	5.08	1.09	2.87	0.262	100.01	35	105	38	324	27	438	320	137	31	13.0	70	103	21
GRB	Basalt of Meyer Ridge	54.31	1.700	14.40	11.01	0.196	9.00	4.90	1.27	2.93	0.273	99.99	26	95	35	320	35	467	306	143	30	12.0	56	113	15
GRB	Basalt of Meyer Ridge	53.56	1.546	14.79	10.87	0.180	9.58	5.61	0.92	2.70	0.245	100.00	46	141	41	290	24	434	316	130	29	13.0	90	111	18
GRB	Basalt of Meyer Ridge	53.08	1.672	15.06	11.33	0.173	9.46	5.37	0.78	2.81	0.263	100.00	37	126	39	322	15	470	314	139	28	12.0	75	113	16
GRB	Basalt of Meyer Ridge	53.08	1.672	15.06	11.33	0.173	9.46	5.37	0.78	2.81	0.263	100.00	37	126	39	322	15	470	314	139	28	12.0	75	113	16
GRB	Basalt of Meyer Ridge	54.07	1.585	15.01	10.35	0.155	9.56	5.30	0.91	2.81	0.249	100.00	38	142	41	326	18	350	311	128	31	10.5	79	97	17
GRB	Basalt of Meyer Ridge	53.69	1.622	14.98	10.06	0.157	10.10	5.42	0.88	2.84	0.248	100.00	32	135	47	313	25	346	325	132	31	11.1	47	101	22
GRB	Basalt of Meyer Ridge	54.77	1.765	14.89	9.43	0.184	9.27	5.00	1.21	3.20	0.283	100.00	30	86	44	329	31	489	324	149	34	9.7	47	111	22
GRB	Basalt of Meyer Ridge	53.32	1.677	14.56	11.51	0.165	9.45	5.23	0.83	2.99	0.260	99.99	20	94	45	317	20	408	316	140	33	11.1	57	101	20
GRB	Basalt of Meyer Ridge	54.23	1.730	14.50	10.88	0.183	9.12	4.91	1.07	3.10	0.277	100.00	20	95	45	323	24	479	308	143	33	11.3	43	107	20
GRB	Basalt of Meyer Ridge	54.02	1.746	14.59	10.63	0.179	9.33	5.06	1.04	3.13	0.279	100.00	19	82	43	332	24	437	312	143	33	13.5	50	163	24
GRB	Basalt of Meyer Ridge	53.53	1.650	14.54	10.98	0.185	9.53	5.39	1.02	2.92	0.264	100.01	27	105	43	307	26	469	313	138	31	11.8	64	102	20
GRB	Basalt of Meyer Ridge	54.21	1.738	14.46	10.74	0.181	9.09	5.05	1.14	3.11	0.278	100.00	20	98	40	314	24	480	309	146	33	12.1	49	107	20
GRB	Basalt of Meyer Ridge	53.89	1.730	14.49	10.83	0.169	9.45	5.04	1.03	3.09	0.275	99.99	20	85	47	328	21	433	311	142	33	11.3	54	105	22
GRB	Basalt of Meyer Ridge	51.73	1.703	14.57	12.55	0.25	9.76	5.46	0.66	2.97	0.358	100.00	15	123	42	347	9	553	367	130	33	10.9	52	107	23
GRB	Basalt of Meyer Ridge	54.42	1.750	14.69	10.07	0.169	9.51	4.91	1.24	2.96	0.280	100.00	21	93	39	318	28	409	314	144	33	12.8	71	108	23
GRB	Basalt of Meyer Ridge	53.84	1.655	14.77	10.26	0.174	9.77	5.29	0.94	3.04	0.258	100.00	24	118	45	318	20	411	325	136	31	10.5	64	106	21
GRB	Basalt of Meyer Ridge	52.35	1.768	14.88	12.56	0.173	9.24	5.06	0.72	2.98	0.276	100.01	18	97	37	326	18	422	324	149	32	10.2	36	112	17
GRB	Basalt of Meyer Ridge	54.38	1.713	14.44	10.92	0.171	9.00	5.02	1.17	2.93	0.267	100.01	22	97	38	328	27	499	313	141	30	10.9	46	99	18
GRB	Basalt of Meyer Ridge	54.00	1.706	14.38	11.00	0.189	9.12	5.29	1.10	2.95	0.267	100.00	21	90	41	320	29	507	314	140	31	11.1	53	107	19
GRB	Basalt of Meyer Ridge	53.90	1.596	14.68	10.67	0.174	9.62	5.40	0.92	2.79	0.256	100.01	34	119	40	320	19	404	312	133	31	11.7	70	101	17
GRB	Basalt of Meyer Ridge	54.61	1.684	14.62	10.67	0.188	8.96	4.99	1.14	2.86	0.267	99.99	22	99	37	323	25	494	307	140	32	12.			

**Table G.1.** (contd)

Formation	Unit Ident.	Major Oxides (weight per cent)										Trace Elements (ppm)													
		SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO*	MnO	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	TOTAL	Ni	Cr	Sc	V	Rb	Ba	Sr	Zr	Y	Nb	Cu	Zn	Ga
GRB	Basalt of Meyer Ridge	54.19	1.673	14.40	11.06	0.202	8.88	5.12	1.18	3.04	0.267	100.01	21	96	43	306	29	731	323	141	31	11.3	45	108	19
GRB	Basalt of Meyer Ridge	54.22	1.713	14.33	10.95	0.186	8.87	5.19	1.11	3.17	0.271	100.01	20	95	39	316	26	480	303	144	31	12.4	51	107	21
GRB	Basalt of Meyer Ridge	53.63	1.636	14.26	11.35	0.199	9.33	5.38	0.94	3.01	0.258	99.99	22	102	40	311	18	483	310	135	31	10.6	50	102	22
GRB	Basalt of Meyer Ridge	54.39	1.711	14.35	10.76	0.186	8.92	5.16	1.09	3.16	0.274	100.00	20	100	39	326	24	505	308	144	29	11.5	52	107	21
GRB	Basalt of Meyer Ridge	52.47	1.718	14.18	11.71	0.202	9.64	5.67	1.19	2.92	0.290	99.99	11	110	47	342	20	384	351	130	31	10.6	40	108	21
GRB	Basalt of Meyer Ridge	53.28	1.702	14.43	11.31	0.196	9.86	5.00	0.97	2.95	0.288	99.99	8	107	50	363	27	400	361	129	29	10.9	40	111	20
GRB	Basalt of Meyer Ridge	54.40	1.691	14.64	10.24	0.172	9.16	5.20	1.20	3.03	0.267	100.00	20	96	44	327	28	475	311	141	30	10.2	50	104	19
GRB	Basalt of Meyer Ridge	54.49	1.735	14.37	10.48	0.187	9.01	5.19	1.19	3.08	0.266	100.00	22	93	37	330	25	460	308	142	30	10.0	49	110	20
GRB	Basalt of Meyer Ridge	54.25	1.724	14.56	10.29	0.185	9.33	5.22	1.11	3.07	0.270	100.01	24	102	37	321	22	474	310	141	30	10.4	55	104	17
GRB	Basalt of Meyer Ridge	51.72	1.771	15.53	12.64	0.181	9.76	4.72	0.44	2.98	0.254	100.00	22	119	45	306	8	408	329	146	30	11.7	51	106	23
GRB	Basalt of Meyer Ridge	53.52	1.672	14.76	10.56	0.172	9.67	5.40	0.96	3.03	0.254	100.00	25	112	41	317	22	423	320	136	35	10.9	83	123	21
GRB	Basalt of Meyer Ridge	54.45	1.693	14.84	10.44	0.184	9.02	5.08	1.04	3.00	0.266	100.01	28	105	37	316	18	436	300	138	32	12.0	50	103	23
GRB	Basalt of Meyer Ridge	54.83	1.684	14.66	10.18	0.191	9.01	5.12	1.17	2.89	0.267	100.00	34	106	38	331	27	431	296	137	32	13.0	52	102	19
GRB	Basalt of Meyer Ridge	54.14	1.624	14.62	10.60	0.191	9.33	5.34	1.14	2.74	0.263	99.99	32	109	43	312	26	403	304	134	30	12.7	61	98	21
GRB	Basalt of Meyer Ridge	55.43	1.718	14.89	9.30	0.179	9.13	5.02	1.11	2.94	0.278	100.00	29	117	43	310	24	570	312	143	33	12.1	51	102	21
GRB	Basalt of Meyer Ridge	54.48	1.741	14.58	10.42	0.198	9.22	5.27	0.86	2.96	0.267	100.00	26	89	41	321	22	620	311	144	33	12.9	37	107	20
GRB	Basalt of Meyer Ridge	53.57	1.640	14.55	11.14	0.185	9.34	5.33	1.02	2.97	0.261	100.01	25	89	36	307	25	417	311	137	31	11.0	83	111	22
GRB	Basalt of Meyer Ridge	53.45	1.608	14.94	11.19	0.192	9.70	5.02	0.84	2.80	0.252	99.99	31	131	37	307	25	422	331	136	32	11.0	79	110	15
GRB	Basalt of Meyer Ridge	53.52	1.577	14.68	11.12	0.238	9.50	5.46	0.89	2.75	0.250	99.99	32	123	36	298	24	508	311	131	29	11.0	80	105	16
GRB	Basalt of Meyer Ridge	53.57	1.508	14.96	10.41	0.179	9.51	5.89	0.94	2.80	0.241	100.01	40	141	39	292	24	379	305	126	28	11.0	68	99	20
GRB	Basalt of Meyer Ridge	53.43	1.614	14.94	11.42	0.166	9.50	5.20	0.90	2.59	0.251	100.01	35	126	38	304	26	369	322	135	30	11.0	80	109	21
GRB	Basalt of Meyer Ridge	54.09	1.588	14.89	10.13	0.168	9.54	5.44	0.99	2.92	0.252	100.01	36	152	36	304	21	470	310	132	30	11.0	59	99	19
GRB	Basalt of Meyer Ridge	53.54	1.538	14.81	10.71	0.196	9.70	5.59	0.85	2.83	0.244	100.01	35	134	38	315	16	468	313	131	30	11.0	77	104	24
GRB	Basalt of Meyer Ridge	54.45	1.688	14.37	10.89	0.194	8.98	5.09	1.29	2.78	0.274	100.01	25	98	38	311	34	400	301	138	33	13.2	49	104	19
GRB	Basalt of Meyer Ridge	54.19	1.703	14.35	10.73	0.192	9.38	5.10	1.24	2.84	0.274	100.00	31	91	41	314	29	393	308	139	34	12.0	66	107	25
GRB	Basalt of Meyer Ridge	54.11	1.633	14.47	10.62	0.199	9.33	5.44	1.11	2.82	0.267	100.00	30	101	38	305	27	379	304	132	29	10.6	62	100	20
GRB	Basalt of Meyer Ridge	53.99	1.588	14.39	10.72	0.189	9.48	5.50	1.03	2.85	0.260	100.00	34	116	38	294	25	371	305	131	31	9.3	68	98	23
GRB	Basalt of Meyer Ridge	53.91	1.553	14.58	10.26	0.189	9.70	5.75	0.94	2.87	0.246	100.00	38	131	39	307	22	344	308	124	29	8.5	67	97	22
GRB	Basalt of Meyer Ridge	54.79	1.730	14.84	11.79	0.200	8.10	3.97	1.20	3.09	0.280	99.99	31	-	-	259	21	546	318	147	34	12.7	60	103	18
GRB	Basalt of Meyer Ridge	54.85	1.730	14.83	11.70	0.200	8.12	4.02	1.20	3.06	0.280	99.99	43	-	-	289	23	518	318	148	36	13.4	59		

**Table G.1.** (contd)

Formation	Unit Ident.	Major Oxides (weight per cent)										Trace Elements (ppm)													
		SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO*	MnO	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	TOTAL	Ni	Cr	Sc	V	Rb	Ba	Sr	Zr	Y	Nb	Cu	Zn	Ga
GRB	R2 MSU undiff.	54.56	1.891	14.14	12.20	0.198	8.36	4.17	1.32	2.75	0.416	100.00	5	41	39	243	31	496	317	163	38	15.2	24	116	24
GRB	R2 MSU undiff.	55.20	2.362	13.52	13.01	0.214	7.13	3.39	1.78	3.01	0.400	100.00	3	16	37	363	46	651	321	172	39	15.2	6	128	21
GRB	R2 MSU undiff.	54.39	2.294	13.62	12.80	0.186	7.27	3.66	1.63	3.71	0.450	100.00	9	14	42	379	42	648	312	181	40	15.7	27	126	23
GRB	R2 MSU undiff.	54.21	2.202	13.70	13.18	0.179	7.55	3.77	1.57	3.22	0.420	100.00	3	20	46	362	44	598	324	180	41	14.3	39	126	21
GRB	R2 MSU undiff.	54.40	2.511	13.68	12.57	0.208	7.26	3.61	1.81	3.50	0.445	100.00	7	15	44	416	43	681	316	193	41	14.8	19	135	23
GRB	R2 MSU undiff.	54.15	2.563	13.74	12.82	0.171	6.94	4.01	1.68	3.48	0.436	100.00	9	20	37	431	43	632	314	187	39	14.1	19	131	20
GRB	R2 MSU undiff.	54.05	2.564	13.73	12.83	0.171	6.96	3.96	1.69	3.60	0.439	100.00	7	18	43	439	45	636	315	187	38	14.0	18	130	25
GRB	R2 MSU undiff.	56.31	2.197	13.85	12.02	0.164	6.36	3.08	1.89	3.72	0.406	100.00	0	17	37	339	60	689	343	184	36	13.1	5	124	22
GRB	R2 MSU undiff.	54.31	2.515	13.61	13.06	0.232	7.22	3.56	1.65	3.41	0.441	100.00	2	18	40	409	39	659	320	190	41	13.3	14	129	22
GRB	R2 MSU undiff.	54.43	2.194	13.80	12.29	0.204	7.68	3.88	1.57	3.53	0.419	100.00	4	18	45	378	38	593	320	179	39	14.9	41	126	21
GRB	R2 MSU undiff.	54.53	2.311	13.66	12.84	0.194	7.50	3.53	1.61	3.39	0.442	100.00	7	16	40	379	36	635	324	182	40	16.0	22	123	23
GRB	R2 MSU undiff.	54.43	2.511	13.79	11.59	0.201	8.13	4.09	1.56	3.22	0.485	100.00	2	27	41	305	31	576	321	178	38	14.3	20	136	21
GRB	R2 MSU undiff.	55.47	2.341	13.81	11.87	0.192	7.29	3.50	1.72	3.34	0.466	100.00	9	18	36	360	46	1023	328	183	37	16.1	25	131	20
GRB	R2 MSU undiff.	54.50	2.205	13.66	12.51	0.206	7.60	3.94	1.59	3.37	0.415	100.00	3	22	44	370	41	592	308	175	36	14.0	36	127	22
GRB	R2 MSU undiff.	55.13	2.047	13.87	11.81	0.195	7.61	3.89	1.67	3.44	0.345	100.00	5	17	41	352	41	612	309	169	33	13.6	23	118	21
GRB	R2 MSU undiff.	55.01	2.250	13.60	12.37	0.201	7.38	3.55	1.81	3.42	0.407	100.00	2	16	40	379	42	624	309	178	38	12.3	17	126	21
GRB	R2 MSU undiff.	53.47	2.560	13.64	13.07	0.189	8.38	4.08	1.13	3.00	0.474	100.00	0	23	39	307	28	517	331	178	39	13.1	8	126	24
GRB	R2 MSU undiff.	55.46	2.117	13.80	11.56	0.193	7.70	4.05	1.43	3.35	0.345	100.00	0	17	36	363	31	572	320	165	35	11.3	8	122	25
GRB	R2 MSU undiff.	54.83	2.173	13.79	11.80	0.199	7.93	4.12	1.60	3.20	0.362	100.00	2	18	36	388	34	513	323	161	34	10.5	9	125	21
GRB	R2 MSU undiff.	56.06	2.221	13.95	11.82	0.188	6.93	3.34	1.93	3.15	0.401	100.00	0	15	34	336	52	691	348	180	37	12.7	1	125	24
GRB	R2 MSU undiff.	55.61	2.367	13.57	12.61	0.221	6.63	2.92	1.94	3.64	0.476	100.00	0	11	33	354	58	682	309	198	39	14.2	7	137	23
GRB	R2 MSU undiff.	55.78	2.361	13.64	12.25	0.220	6.63	2.96	1.94	3.75	0.475	100.00	0	10	34	353	56	700	310	196	40	14.0	9	136	22
GRB	R2 MSU undiff.	57.15	2.426	14.48	9.63	0.26	6.87	3.16	2.39	3.19	0.448	100.00	0	12	28	331	58	780	340	209	41	16.0	4	137	25
GRB	R2 MSU undiff.	54.80	2.559	13.80	11.90	0.218	7.37	3.66	1.72	3.51	0.464	100.00	10	17	34	396	39	697	323	188	42	15.3	17	127	19
GRB	R2 MSU undiff.	54.90	2.564	13.85	11.68	0.219	7.41	3.68	1.72	3.52	0.468	100.00	7	18	30	406	38	711	324	189	43	14.5	14	134	24
GRB	R2 MSU undiff.	54.39	1.935	13.92	12.18	0.202	8.41	4.28	1.31	2.97	0.413	100.00	4	38	34	271	30	485	317	168	38	12.3	15	121	23
GRB	R2 MSU undiff.	57.27	2.002	14.00	10.52	0.174	6.97	3.30	2.15	3.28	0.332	100.00	0	13	35	323	56	768	317	186	37	12.9	6	121	21
GRB	R2 MSU undiff.	55.40	2.307	13.85	11.82	0.200	7.29	3.56	1.89	3.26	0.414	99.99	5	18	40	370	44	899	328	184	40	12.9	23	132	23
GRB	R2 MSU undiff.	52.70	2.512	14.77	14.29	0.191	7.31	3.16	1.25	3.34	0.471	99.99	7	17	42	369	32	685	350	197	38	16.4	34	131	26
GRB	R2 MSU undiff.	54.66	2.511	13.76	12.33	0.197	7.25	3.52	1.78	3.54	0.452	100.00	5	15	37	394	40	706	324	195	42	13.8	22	132	21
GRB	R2 MSU undiff.																								

**Table G.1.** (contd)

Formation	Unit Ident.	Major Oxides (weight per cent)										Trace Elements (ppm)													
		SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO*	MnO	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	TOTAL	Ni	Cr	Sc	V	Rb	Ba	Sr	Zr	Y	Nb	Cu	Zn	Ga
GRB	R2 MSU undiff.	55.61	2.290	13.64	12.78	0.200	6.82	3.17	2.18	2.85	0.460	100.00	20	-	-	335	52	715	317	196	42	15.1	20	128	23
GRB	R2 MSU undiff.	55.86	2.280	13.85	11.92	0.190	6.87	3.28	2.06	3.27	0.420	100.00	12	-	-	307	50	737	317	196	39	17.0	10	119	25
GRB	R2 MSU undiff.	53.55	2.580	14.23	13.76	0.220	7.20	3.46	1.78	2.76	0.460	100.00	31	-	-	377	43	656	335	194	40	17.1	29	125	23
GRB	R2 MSU undiff.	54.37	2.120	13.66	13.07	0.200	7.55	3.86	1.71	3.04	0.430	100.01	32	-	-	359	43	588	311	175	36	14.8	51	118	19
GRB	R2 MSU undiff.	54.65	2.130	13.68	12.72	0.200	7.62	3.78	1.76	3.04	0.410	99.99	26	-	-	354	45	582	314	173	37	14.2	44	118	24
GRB	R2 MSU undiff.	57.09	2.380	14.04	10.13	0.200	7.19	3.38	2.04	3.09	0.460	100.00	40	-	-	323	52	986	359	187	40	16.0	36	128	20
GRB	R2 MSU undiff.	57.08	2.400	14.02	10.09	0.200	7.24	3.33	2.08	3.11	0.460	100.01	69	-	-	339	53	999	359	190	41	17.0	29	128	21
GRB	N1 MSU undiff.	54.60	1.869	14.11	12.15	0.186	8.01	4.20	1.53	3.04	0.307	100.00	2	18	40	332	29	507	328	160	35	10.9	29	112	22
GRB	N1 MSU undiff.	54.44	1.708	14.53	11.13	0.166	8.71	4.98	1.07	3.01	0.256	100.00	5	22	35	313	24	470	340	148	31	9.7	35	103	21
GRB	N1 MSU undiff.	54.97	1.712	14.49	10.70	0.173	8.62	4.81	1.30	2.97	0.259	100.00	5	24	35	318	35	425	327	144	30	10.4	24	104	18
GRB	N1 MSU undiff.	55.04	1.973	14.19	11.75	0.207	7.96	4.12	1.10	3.31	0.348	100.00	5	20	36	390	20	535	325	160	34	10.4	16	123	20
GRB	N1 MSU undiff.	55.34	1.693	14.43	11.04	0.143	7.97	4.75	1.23	3.16	0.247	100.00	8	28	39	311	37	440	318	142	31	10.0	36	103	19
GRB	N1 MSU undiff.	55.10	1.713	14.50	10.99	0.179	8.42	4.72	1.15	2.96	0.272	100.00	10	28	39	316	28	448	324	144	34	12.7	39	109	20
GRB	N1 MSU undiff.	54.90	1.672	14.52	10.90	0.184	8.56	4.83	1.13	3.06	0.253	100.01	11	33	39	316	27	442	323	140	30	10.4	34	103	21
GRB	N1 MSU undiff.	55.10	1.694	14.77	10.42	0.173	8.73	4.86	1.11	2.86	0.271	99.99	14	43	34	316	26	428	330	142	34	11.5	27	104	20
GRB	N1 MSU undiff.	57.51	2.180	13.66	11.25	0.180	6.55	2.91	2.05	3.38	0.320	99.99	50	-	-	348	53	693	315	196	39	15.2	26	127	22
GRB	N1 MSU undiff.	55.76	2.050	13.98	11.79	0.170	7.60	3.85	1.65	2.84	0.290	99.98	30	-	-	309	42	551	318	173	36	14.4	48	112	19
GRB	N1 MSU undiff.	56.14	2.060	14.10	11.28	0.170	7.60	3.86	1.65	2.84	0.290	99.99	34	-	-	345	45	606	320	178	35	14.3	43	111	21
GRB	N1 MSU undiff.	55.44	2.000	13.75	12.04	0.210	7.75	3.91	1.57	3.02	0.310	100.00	27	-	-	323	40	572	317	172	34	14.6	39	111	20
GRB	N1 MSU undiff.	55.01	2.110	13.65	12.43	0.210	7.51	3.75	1.75	3.15	0.430	100.00	45	11	37	387	36	613	319	181	40	13.9	60	128	21
GRB	N1 MSU undiff.	55.32	2.120	14.02	11.89	0.200	7.56	3.61	1.75	3.12	0.420	100.01	33	-	-	394	37	668	325	183	40	13.4	52	124	20
GRB	N1 MSU undiff.	55.87	2.000	13.74	12.45	0.190	7.21	3.67	1.64	2.91	0.310	99.99	25	5	31	349	44	560	311	183	38	16.0	30	113	21
GRB	N1 MSU undiff.	55.99	1.710	14.12	11.23	0.190	7.79	4.18	1.39	3.17	0.230	100.00	26	7	34	312	35	487	315	150	31	12.8	16	102	23
GRB	N1 MSU undiff.	56.14	1.740	14.27	11.07	0.190	7.79	4.05	1.62	2.90	0.230	100.00	15	-	-	320	47	517	318	153	32	12.6	22	105	20
GRB	N1 MSU undiff.	54.96	1.690	14.60	10.64	0.190	8.61	4.81	1.37	2.85	0.280	100.00	31	-	-	292	31	519	323	147	31	12.0	19	104	18
GRB	N1 MSU undiff.	55.08	1.670	14.55	10.96	0.190	8.63	4.74	1.18	2.75	0.270	100.02	30	-	-	285	30	450	317	145	31	12.0	24	106	20
GRB	N1 MSU undiff.	54.62	2.130	13.64	13.00	0.210	7.48	3.82	1.68	3.04	0.390	100.01	16	-	-	365	41	548	310	161	34	11.8	16	114	21
GRB	N1 MSU undiff.	54.62	2.240	13.56	12.67	0.210	7.64	3.75	1.78	3.11	0.420	100.00	26	-	-	422	38	554	314	168	38	15.4	42	122	19
GRB	N1 MSU undiff.	54.69	2.170	13.83	13.03	0.170	7.62	3.73	1.52	2.86	0.390	100.01	23	19	34	381	38	532	322	160	35	13.1	21	119	22
GRB	N1 MSU undiff.	55.15	2.010	14.05	11.73	0.200	7.83	4.05	1.51	3.08	0.390	100.00	27	-	-	368	37	521	319	160	34	12.2	32	117	18
GRB	N1 MSU undiff.	54.41	2.010	13.72	13.06	0.2																			

**Table G.1.** (contd)

Formation	Unit Ident.	Major Oxides (weight per cent)										Trace Elements (ppm)													
		SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO*	MnO	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	TOTAL	Ni	Cr	Sc	V	Rb	Ba	Sr	Zr	Y	Nb	Cu	Zn	Ga
GRB	R1 MSU undiff.	54.38	2.230	13.71	12.48	0.250	7.83	4.05	1.40	3.28	0.380	99.99	28	-	-	378	33	500	313	183	39	16.0	89	120	22
GRB	R1 MSU undiff.	54.02	2.230	13.72	12.86	0.230	7.78	4.19	1.30	3.28	0.380	99.99	38	-	-	372	21	520	316	181	39	16.4	86	121	19
GRB	R1 MSU undiff.	54.31	2.280	13.90	12.15	0.190	7.90	4.21	1.42	3.26	0.380	100.00	51	34	33	337	26	522	330	184	35	15.3	72	116	22
GRB	R1 MSU undiff.	54.44	2.290	13.92	12.02	0.190	8.01	4.24	1.37	3.14	0.380	100.00	41	-	-	298	23	527	343	186	36	15.6	71	109	21
GRB	R1 MSU undiff.	54.52	2.270	14.12	11.77	0.230	8.09	3.97	1.56	3.09	0.380	100.00	32	-	-	321	52	694	355	183	36	17.3	79	110	24
GRB	R1 MSU undiff.	54.14	2.120	14.27	11.34	0.180	8.36	4.74	1.33	3.20	0.310	99.99	53	-	-	317	25	467	334	177	34	15.3	88	112	21
GRB	R1 MSU undiff.	54.33	2.130	14.32	11.34	0.210	8.43	4.58	1.45	2.90	0.310	100.00	56	-	-	309	40	503	339	182	35	16.2	68	112	23
GRB	R1 MSU undiff.	54.20	2.110	14.36	11.64	0.190	8.37	4.46	1.32	3.03	0.310	99.99	84	39	34	343	34	503	351	177	34	13.7	67	112	20
GRB	R1 MSU undiff.	55.07	2.070	14.41	11.70	0.190	7.54	4.08	1.30	3.28	0.360	100.00	16	-	-	342	21	617	360	183	34	15.3	37	119	23
Imnaha		49.64	1.852	16.55	11.61	0.174	9.35	6.98	1.03	2.57	0.242	100.00	133	120	30	256	24	216	527	134	26	10.0	94	92	18
Imnaha		49.99	2.066	16.17	11.64	0.171	9.53	6.45	0.71	3.00	0.264	100.00	117	128	33	268	14	244	391	149	30	13.0	129	102	20
Imnaha		50.07	2.221	16.00	12.48	0.203	7.97	5.63	0.45	4.70	0.267	100.00	95	137	30	302	8	163	378	151	29	12.3	168	107	17
Imnaha		49.31	2.405	16.59	12.57	0.175	8.75	6.38	0.72	2.79	0.309	100.00	121	135	30	268	12	261	354	164	31	13.6	175	109	24
Imnaha		51.28	2.703	14.15	13.37	0.206	9.14	4.60	0.98	3.19	0.378	100.00	41	111	35	375	20	371	321	198	42	16.0	135	128	21
Imnaha		51.30	2.226	16.38	11.06	0.163	9.11	5.48	0.94	3.04	0.287	100.00	43	81	31	259	25	321	368	165	31	14.6	106	104	24
Imnaha		52.86	2.777	13.33	13.87	0.235	8.05	4.00	1.15	3.25	0.480	100.00	13	25	33	392	30	447	315	228	47	20.1	82	135	22
Imnaha		49.24	1.921	16.53	11.48	0.177	9.36	6.80	2.35	1.90	0.246	100.00	110	120	29	276	65	189	324	135	30	11.9	98	93	20

This information was compiled from:  
Reidel, S. P., unpublished data.

- Reidel, S. P. 1988. Geologic Map of the Saddle Mountains, South-Central Washington: Washington Division of Geology and Earth Resources, Geologic Map 38.
- Sinclair, K., and R. D. Bentley. 1998. Stratigraphic Correlations of the N2 Grande Ronde Basalt Across the Kittitas Valley, Washington, State: Bachelor of Science Thesis, Central Washington University, Ellensburg, Washington.
- Hutter, I. L. 1997. The Wallula Fault Zone: A Study of the Structure and Tectonic History of a Portion of the Olympic-Wallowa Lineament: Western Washington University Masters of Science Thesis, Bellingham, Washington.
- Hagood, M. C. 1986. Structure and Evolution of the Horse Heaven Hills in South-Central Washington: Portland State University Masters of Science Thesis, Portland, Oregon.
- Tolan, T. L., with M. H. Beeson. 1982. The Stratigraphic Relationships of the Columbia River Basalt Group in the Lower Columbia Gorge of Oregon and Washington: Masters of Science Thesis, Portland State University.
- Hooper, P. R., and B. A. Gillespie. 1996. Geologic Map of the Pomeroy Area, Southeastern Washington: Washington Division of Geology and Earth Resources Open-File Report 96-5.
- Bentley, R., unpublished data, Central Washington University, and J. E. Schuster (compiler). 1993. Geologic Map of the Clarkston 1:100,000 Quadrangle, Washington-Idaho and the Washington Portion of the Orofino 1:100,000 Quadrangle: Washington Division of Geology and Earth Resources Open-File Report 93-4.
- Derkey, R. E., M. M. Hamilton, and D. F. Stradling. 1999. Preliminary Geologic Map of the Spokane NE 7.5-Minute Quadrangle, Spokane County, Washington: Washington Division of Geology and Earth Resources Open-File Report 99-6.
- Reidel, S. P., and M. M. Valenta. 2000. Preliminary Chemistry, Petrology, and Paleomagnetism Data for the Sentinel Bluffs Member, Columbia River Basalt Group. PNWD-3063, Battelle Pacific Northwest National Laboratories, Richland, Washington.
- SMB = Saddle Mountains Basalt.
- WB = Wanapum Basalt.
- GRB = Grande Ronde Basalt.